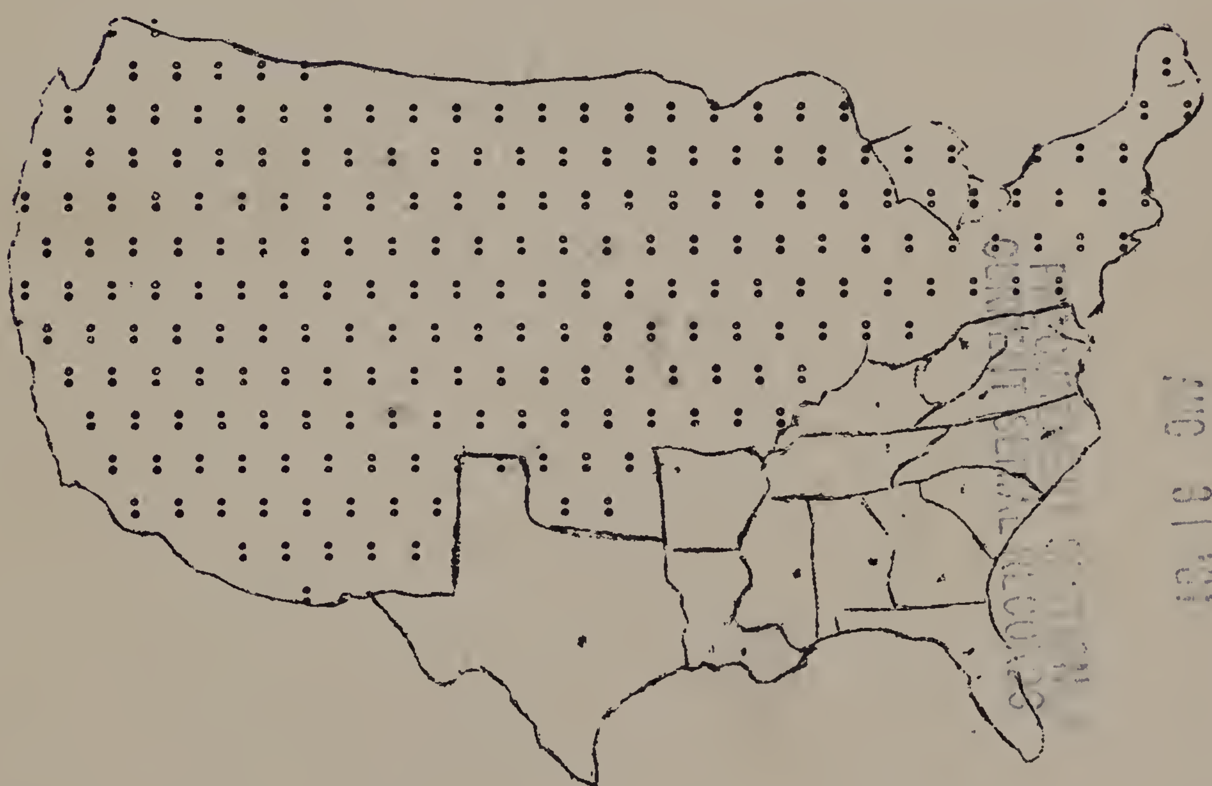
E. J. Warwick

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
ANIMAL HUSBANDRY RESEARCH DIVISION
AND
COOPERATING SOUTHERN STATES
S-10

Improvement of Beef Cattle Through Breeding Methods

1959 Annual Report
and
Proceedings S-10 Technical Committee Meeting
Stillwater, Oklahoma
July 25 - 27, 1960



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This is a report of project leaders and the Regional Coordinator covering research projects not yet completed. It is intended for the use of administrative leaders and workers in this or related fields of research. The material is not intended for general distribution and should not be quoted in publications.

C O N T E N T S

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PERSONNEL OF THE S-10 PROJECT

STATE AGRICULTURAL EXPERIMENT STATION WORKERS
(Asterisk indicates Technical Committee Members for 1960)

Alabama	*T. B. Patterson, W. M. Warren	Auburn, Ala.
Arkansas	*Warren Gifford, C. J. Brown	Fayetteville, Ark.
Florida	*Marvin Koger, A. C. Warnick	Gainesville, Fla.
	W. G. Kirk, F. M. Peacock	Ona, Fla.
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Kentucky	*Neil Bradley	Lexington, Ky.
Louisiana	*R. S. Temple	Baton Rouge, La.
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Mississippi	*C. E. Lindley, J. C. Taylor, Bryan Baker	State College, Miss.
North Carolina	*J. H. Gregory, E. U. Dillard, J. E. Legates, D. G. Spruill	Raleigh, N. C.
South Carolina	*W. C. Godley	Clemson, S. C.
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Tennessee	*C. S. Hobbs, H. J. Smith, J. W. High, J. W. Cole, C. B. Ramsey, R. J. Cooper, Ralph Dodson	Knoxville, Tenn.
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	J. A. Odom	Crossville, Tenn.
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	E. J. Chapman	Spring Hill, Tenn.
	J. McLaren	Grand Junction, Tenn.
Texas	Walter E. Kruse	McGregor, Tex.
	*T. C. Cartwright, R. E. Patterson, Sylvia Cover, G. T. King, H. O. Kunkel	College Station, Tex.
	A. A. Melton	Balmorhea, Tex.
	J. P. Smith, George Ellis	Panhandle, Tex.
Virginia	*J. A. Gaines, G. W. Litton, R. C. Carter, T. J. Marlowe, J. S. Copenhaver	Blacksburg, Va.
	K. P. Bovard	Front Royal, Va.
	Roy Hammes	Middleburg, Va.
	William McClure	Steeles Tavern, Va.
West Virginia	*H. E. Kidder, G. C. Anderson	Morgantown, W.Va.

U. S. DEPARTMENT OF AGRICULTURE WORKERS

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W. C. Burns, Supt., West Central Fla. Expt. Sta. . . . . . . Brooksville, Fla.

REGIONAL OFFICERS - 1960

R. E. Patterson, Administrative Advisor . . . . College Station, Texas
T. C. Cartwright, Chairman . . . . McGregor, Texas
Marvin Koger, Secretary . . . . Gainesville, Florida
W. C. Godley, Executive Committee Member . . . . . . Clemson, South Carolina

INTRODUCTION

This project was initiated in 1948 to investigate and develop methods of breeding more productive beef cattle for the South. Detailed Annual Reports showing research developments and progress in each state have been prepared in each year since 1950. Earlier reports included material on the overall program, and will not be repeated here. A limited number of earlier reports for some years are available and may be obtained from the Regional Coordinator.

This publication includes the annual report on projects in each of the 14 cooperating states and the proceedings of the 1960 Joint Meeting of the S-10, NC-1 and W-1 Technical Committees. The state reports were prepared by station project leaders and personnel as summaries of research developments and progress at each Station during 1959. The results are not considered as final, but the material will aid cooperators and the Coordinator in developing an integrated program. This report also provides information needed by heads of Animal Husbandry Departments, Experiment Station Directors, and U. S. Department of Agriculture officials for evaluation of the projects with respect to objectives and procedures. This report is not for general distribution and material in it should not be quoted in publications.

SCOPE OF PROJECT AND RECENT DEVELOPMENTS

Agricultural Experiment Stations in 14 states and the Animal Husbandry Research Division of the Agricultural Research Service, U. S. Department of Agriculture had active contributing projects in the program in 1959. Experimental cattle were maintained at 36 Experiment Stations and substations in the Region. Thirty-three of these were State-owned and three Federally-owned. The latter three stations located at Jeanerette, Louisiana; Brooksville, Florida; and Front Royal, Virginia, were in each case operated cooperatively with the state in which they were located.

As of July 1, 1960 there were 13,407 head of beef cattle in research herds at stations in the Project. This included 6,255 cows and heifers over two years of age, 1,507 yearling heifers, 4,349 calves, 484 bulls and 810 steers (Table 1). In comparison with the inventory on July 1, 1959 the number of breeding cattle increased by about 15%, and reflects an expansion in numbers at several stations in the Region. Postweaning feeding and grazing tests (Table 2) included 914 young bulls, 738 heifers, and 779 steers. This was about the same numbers on feeding tests as in the previous year.

The S-10 Project continues to be a diversified project with respect to types and kinds of cattle in the breeding herds. In all, there were some 63 genetically different kinds of calves with respect to fraction of breed in the 1959 calf crop. The number of calves in the different breed

TABLE 1

CATTLE INVENTORY AND PERCENT USE IN S-10 PROJECTS

July 1, 1960

STATE	Cows 2 yrs & over	Yearling Heifers	Calves Under 12 mos	Bulls over 12 mos	Steers over 12 mos	Total Numbers	Used in Project
Alabama	271	60	196	26	27	580	100%
Arkansas	310	77	237	43	0	667	100%
Florida	326	71	204	16	38	655	81%
Georgia	641	101	504	39	60	1345	100%
Kentucky	40	0	52	2	0	94	75%
Louisiana	447	95	266	9	15	832	100%
Maryland	172	31	139	37	9	388	89%
Mississippi	717	122	548	30	24	1440	54%
N. Carolina	231	73	135	12	34	485	69%
S. Carolina	227	44	135	14	0	420	50%
Tennessee	1114	427	775	126	73	2515	90%
Texas	569	129	432	33	405	1568	100%
Virginia	112	0	102	6	48	268	100%
W. Virginia	91	37	80	4	24	236	100%
FEDERAL-STATE COOPERATIVE STATIONS							
Brooksville Florida	288	87	156	22	0	553	100%
Jeanerette Louisiana	278	67	187	34	55	621	100%
Front Royal Virginia	421	87	201	31	0	740	100%
Totals	6255	1507	4349	484	812	13,407	89%

TABLE 2

NUMBER OF ANIMALS ON FEEDING AND/OR GRAZING TESTS
1959 and 1960

	Bulls		Heifers		Steers		Totals			
STATE	Sta	Coop	Sta	Coop	Sta	Coop	Bulls	Heifers	Steers	All Sexes
Alabama	18	64	66	0	51	0	82	66	51	199
Arkansas	75	15	58	0	11	0	90	58	11	159
Florida	4	0	0	0	12	0	4	0	12	16
Georgia	88	111	47	0	0	0	199	47	0	246
Kentucky	31	1	9	0	19	0	32	9	19	60
Louisiana	0	0	50	0	120	0	0	50	120	170
Maryland	1	40	22	0	37	29	41	22	66	129
Mississippi	0	72	0	0	53	0	72	0	53	125
North Carolina	27	0	32	0	30	0	27	32	30	89
South Carolina	8	0	0	0	32	0	8	0	32	40
Tennessee	87	0	0	0	73	0	87	0	73	160
Texas	28	96	143	25	121	0	124	168	121	413
Virginia	0	0	46	0	46	0	0	46	46	92
West Virginia	0	0	24	0	24	0	0	24	24	48
FEDERAL-STATE COOPERATIVE STATIONS										
Brooksville Florida	37	41	102	0	81	0	81	102	81	264
Jeanerette Louisiana	20	0	70	0	40	0	20	70	40	130
Front Royal Virginia	47	0	90	0	46	0	47	90	46	183
Totals	471	440	759	25	796	29	914	738	779	2523

combinations are shown in table 3, with different kinds of crosses (i.e. first-cross, back-cross, three-way cross, etc.) included in the same category. The approximate percentage in each main type of mating wasaas follows: British breeds, "inter-se" - 68%; Brahman and Brahman-Bri British derivatives, "inter-se" - 8%; crosses among British breeds 6%; and other types of crosses 18%. The recent trend in crossbreeding experiments has been directed toward evaluation of expectation from different crosses which follow a first-cross. This is a very important question to the beef cattle breeder because replacement females must, of necessity, come largely from his own herd. The low reproductive rate in cattle preclude extensive use of herds primarily for the production of replacement stock, as contrasted with the situation in plants and highly fertile species of animals such as poultry.

Emphasis has continued on the development of more precise methods for beef cattle improvement with respect to performance characteristics, such as: growth rate, efficiency, cow productivity, adaptation to environmental conditions, and quality of meat. The latter characteristic continued to receive increased interest in cooperative investigations which tied together Beef Cattle Breeding and Meats Research at ten institutions.

Reproduction in most research herds has been a major problem and indicates that this is an area where efficiency of production could be much improved. In 1959 the calf crop in S-10 herds by age of dam was as follows:

Age when bred	No. bred	% Calved	% Raised Calves	% Calves born that died: At Birth	Birth to Weaning	Total
Yearlings	420	70	59	11.9	4.1	16.0
2-Year Old	919	76	67	9.9	.3	10.2
3-Year Old	847	74	69	5.1	2.2	7.3
4-Year Old/over	2593	79	74	3.9	1.8	5.7
All ages	4779	77	70	5.9	2.2	8.1

Data on lactation status when bred indicated that British type cows and cows with Brahman blood behaved differently with respect to lactation. Reproductive behavior for different types of cows three years of age or older when bred was as follows:

Kind of cow	Not raising a calf: No. Cows	% Calving	Raising a calf: No. Cows	% Calving
British	493	68.2	1925	82.0
Brahman-British	114	78.1	622	75.4
Brahman	48	75.0	118	60.1

These data on reproduction are based on all cows that were bred and that had an opportunity to calve or were pregnancy checked. Pregnancy

NUMBER OF CALVES BORN IN 1959 FROM DIFFERENT TYPES OF MATINGS AT STATIONS COOPERATING IN S-10 PROJECT

TABLE 3

Type of Mating	Number of Matings by States														
	Ala	Ark	Fla	Ga	Ky	La	Md	Miss	N.C.	S.C.	Tenn	Tex	Va	WVa	Total
Inter se															
Angus (A)	46	152	45	59		28	32	65	25	70	285	9	108	37	961
Herefords (H)	81	76	28	207	12	30	22	111	133	47	485	174	99	39	1544
Shorthorns (Sh)	16	20	29			29		34	13				101		242
Brahman (Z)			48			42						20			110
Santa Gert. (Sg)			28	28								10			66
Brangus (ZA)			30			98									128
Afrik-Ang						40									40
Crosses															
A - H	27		53	28		7							11		126
A - Sh	11					8							30		49
H - Sh	9					8							20		37
A - H - Sh													20		20
H - RP					16										16
A - Zn			36												36
H - Zn			40												40
A - H - Zn			26												26
A - Sindhi						9									9
Z - A			29			33									62
Z - H	20					7						90			117
Z - Sh			102			7									109
Z - A - H	4														4
Z - Zn			19												19
ZA - A						6									6
ZA - H						13									13
ZA - Sh						6									6
ZA - Z						13									13
Sg - A				19											19
Sg - H				28								26			54
Sg - RP			7									12			19
Sg - A - H				36											36
Sg - H - Z												16			16
Sg - H - Z - RP												5			5
Sg - Zn			21												21
C - A						7									7
C - H						33						1			34
C - ZA						8									8
C - Z						6						18			24
C - H - Z												19			19
TOTAL	214	248	541	405	28	438	54	210	171	117	770	400	389	76	4061

Breeds or strains not shown in those abbreviated in the table are as follows: Afrikander (Afrik); Charolaise (C); Red Polled (RP); Brahman-native (Zn).

examinations in the fall have been utilized by several stations to cull non-pregnant cows and thus increase the calf crop based on cows in the herd at calving. Routine pregnancy checks at many stations have led to more efficient use of herds and facilities and materially increased effective herd size.

Studies on bovine dwarfism continued at four stations in the Region. The major problem in the control of dwarfism, identification of carriers of the dwarf gene, has not been solved. Breeders have utilized research information to develop breeding methods (pedigree selection and progeny testing) to achieve some control of this abnormality have continued in breeding herds. Investigations on the X-ray technique, biochemistry of blood and tissue constituents, hormones, physiology and other phenotypic expression of the syndrome with animals of presumed known genotypes.

INTEREST OF PUBLIC IN THE PROJECT

On-the-farm testing programs for beef cattle continued to increase throughout the Region. It is estimated that about 100,000 breeding cows are in Beef Cattle Improvement Programs in the South, which utilize techniques developed in this project. Testing stations for the measurement of feedlot performance by young bulls and feed testing by breeders has continued to increase. Most of this performance testing is under the supervision of the Agricultural Extension Service in their respective states. Prices paid for young bulls at Auction Sales where performance information was available to the buyer, indicates that cattlemen are paying a premium for those with good performance records and good conformation.

Field days and sales at stations where results from this Project were featured have been well-attended and reflect the growing interest in the application of these newer tools by cattle breeders. State and local conferences and meetings by breeders have usually included in their program one or more phases of the developments in beef cattle breeding research. This interest in research results and the utilization of these findings as the basis for breeding programs based on systematic records is rapidly putting the industry in a position to more fully exploit improved techniques as they develop.

ALA (1)

Alabama Station

by

Troy B. Patterson

I. PROJECT: Anim. Husb. and Nutr. 525 (S-10)(AHRD d1-29)

The Improvement of the Beef Cattle of Alabama Through Breeding Methods

II. OBJECTIVES:

A. To determine the effectiveness of mass selection for total performance in beef cattle.

B. To develop criteria for evaluating and selecting breeding animals.

C. To study the influence of heterosis in crosses between the three British breeds of beef cattle.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and animals: Two hundred and forty-four cows and replacement heifers are devoted to this project. Of the number, 112 are being used in the cross breeding phase and 132 on the purebred selection phase. Approximately 950 acres of land are being utilized of which about 650 acres have been cleared. About 150 acres have been added as new pasture this year.

B. Research results: The usual data was collected during the year and include birth weight, 90-day weight, 180-day weight and score, 250-day weight and score. Milk production of the dams was determined at 90, 180 and 250-days. Averages by breed of of dam, sex of calf and age of calf as well as the correlation between milk production and weight of calf are shown in Table 1.

Eighteen bulls and 66 heifers completed post-weaning performance test. Two bulls and 39 heifers were retained for breeding purposes based on the results of this test.

Twenty-five crossbred and purebred steers completed a 200-day feeding period. Slaughter data will be obtained. Table 2 gives the slaughter results of a similar group of steers that was not reported one year ago.

IV. FUTURE PLANS:

Revise crossbreeding phase and continue with other phase as before.

V. PUBLICATIONS DURING THE YEAR:

Performance testing program annual report

VI. PUBLICATIONS PLANNED:

None

Table 1

Milk[1] Production, Calf Weight and Correlations[2]

Age and Observation	ANGUS 24 Males	ANGUS 18 Females	HEREFORD 21 Males	HEREFORD 38 Females	SHORTHORN 3 Males	SHORTHORN 12 Females
90 Days						
Weight	184	190	180	188	140	179
Milk	5.51	4.98	4.70	5.50	2.70	4.55
r.	0.64	0.75	0.72	0.33		0.63
180 Days						
Weight	347	318	308	229	258	313
Milk	5.92	5.44	4.08	4.41	3.54	4.87
r.	0.63	0.44	0.76	0.77		0.89
250 Days						
Weight	460	408	426	391	361	399
Milk	5.33	4.98	3.29	3.62	2.99	3.88
r.	0.49	0.57	0.61	0.45		0.57

1/12 hours in pounds of 4% F. C. M.

2/Correlations are between calf weight and milk production. Repeatability estimates on milk production based on successive milkings with 30 pairs of observations was 0.83

Table 2

Crossbreeding Steer Data

Breed No.	Ave. Birth Date	Ave. Birth Weight	Ave. Adj. Weaned Weight	Initial Weight 12/4/58 (Shrunk)	Final Weight 6/20/59 (Shrunk)	(198 day) Ave. Daily Gain	Ave. Carcass Weight (hot)	Ave. dress-ing %	Ave. Carcass Grade (Fed.)	Ave. Rib eye Area (Adjusted)
Angus 3	10/28/57	54	499	543	843	1.54	525	61.9	Choice-	11.1
Hereford 5	11/9/57	59	382	426	763	1.70	460	60.3	Good	12.3
Shorthorn 7	11/22/57	69	441	484	850	1.85	520	61.2	Good	12.2
A x H 3	11/16/57	69	502	533	895	1.84	548	61.3	Good	9.7
A x S 3	11/26/57	53	464	492	825	1.68	507	61.5	Choice	13.0
H x S 4	12/30/57	74	509	568	911	1.73	566	62.2	Choice-	11.3
Ave. 25	11/22/57	64	457	500	844	1.74	518	61.3	Good+	11.7

ALA (5)

Blackbelt Substation

by

Troy B. Patterson and L. A. Smith

I. PROJECT: State

A Comparison of Crossbreeding and Within Breed Selection on Beef Cattle Production in the Blackbelt Area of Alabama

II. OBJECTIVES:

A. To evaluate the significance of hybrid vigor in various crosses of beef cattle with regard to production of slaughter calves, stocker or feeder steers and slaughter steers.

B. To determine the effect of heterosis on mothering ability, adaptability and fertility.

C. To determine the most economical method of finishing steer calves that are dropped in the spring from the above system.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and animals: Sixty brood cows of which 20 are first cross Brahman x Herefords and 40 grade Herefords are being used. In addition, 50 replacement females have been saved for a second phase of the study. Approximately 300 acres of pasture and hay land are required to support this research.

B. Research results: An average of the first three years results are shown in Table 1.

IV. FUTURE PLANS:

Continue on present basis.

V. PUBLICATIONS DURING THE YEAR:

None.

VI. PUBLICATIONS PLANNED:

None.

Blackbelt Substation

Table 1

Weaning Weight of Calves by Breed of Sire and Dam[1/]

Three Year Average (1957-58-59)

	Breed of Dam	
Breed of Sire	Brahman x Hereford	Hereford
Hereford	547 (49)[2/]	558 (54)
Angus		575 (43)

1/ All calves corrected for sex, age of dam and to 254 days of age.
2/ No. of calves involved.

PERFORMANCE OF COW HERDS. 1959 CALVES

Alabama Station

Location Line or group Breed of sire Breed of dam	Auburn Purebreds Angus Angus	Auburn Purebreds Hereford Hereford	Auburn Purebreds Shorthorn Shorthorn	Auburn Crossbreds Angus Angus	Auburn Crossbreds Angus Hereford	Auburn Crossbreds Angus Shorthorn
No. cows calving	35	54	4	11	3	5
No. calves raised	34	51	4	10	2	5
Av. inbr. of calves (%)			10.1			
Av. birth date	11/1/58	11/24/58	11/22/58	11/20/58	11/15/58	11/15/58
Av. birth wt. (lbs.)	57	67	66	53	50	61
Av. weaning age	250	250	250	250	250	250
Av. weaning wt.	493	466	524	468	433	468
Av. weaning type score	11.9	11.5	12.2	11.0	10.0	10.5
Av. weaning condition score	10.2	9.5	11.0	10.6	8.5	9.0
Were calves creep fed?	No	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.74	1.60	1.83	1.66	1.53	1.63

(1) Age of dam and sex.

PERFORMANCE OF COW HERDS. 1959 CALVES

Alabama Station

Location Line or group Breed of sire Breed of dam	Auburn Crossbreds Hereford Hereford	Auburn Crossbreds Hereford Angus	Auburn Crossbreds Hereford Shorthorn	Auburn Crossbreds Shorthorn Shorthorn	Auburn Crossbreds Shorthorn Angus	Auburn Crossbreds Shorthorn Hereford
No. cows calving No. calves raised Av. inbr. of calves (%)	11 10	4 4	4 4	12 11 8.4	6 6	5 5
Av. birth date Av. birth wt. (lbs.)	11/26/58 66	11/14/58 61	10/27/58 62	11/7/58 62	11/15/58 66	11/17/58 70
Av. weaning age Av. weaning wt.	250 465	250 433	250 518	250 453	250 507	250 502
Av. weaning type score Av. weaning condition score	10.4 9.4	11 11	11 10	11 10	11 10	10 10.6
Were calves creep fed?	No	No	No	No	No	No
Adjusted[1] av. daily gain from birth to weaning	1.60	1.48	1.82	1.56	1.76	1.73

[1] Age of dam and sex

PERFORMANCE OF COW HERDS. 1959 CALVES

Blackbelt Alabama Substation

Location	Blackbelt Substation	Blackbelt Substation	Blackbelt Substation	Blackbelt Substation	Blackbelt Substation	Blackbelt Substation
Line or group	Crossbreds	Crossbreds	Crossbreds	Crossbreds	Crossbreds	Crossbreds
Breed of sire	Hereford	Hereford	Angus	Angus	Angus	Angus
Breed of dam	Hereford	1/2 Brah. 1/2 Herf.	Hereford	Hereford (Heifers)	1/4 Brah. 3/4 Herf.	1/2 Herf. 1/2 Angus
No. cows calving	16	20	13	2	4	5
No. calves raised	17	19	13	2	4	5
Av. birth date	11/14/58	10/22/58	3/14/59	10/11/58	9/15/58	9/11/58
Av. birth wt. (lbs.)	67	63	67	52	53	48
Av. weaning age	254	254	254	254	254	254
Av. weaning wt.	554	551	560	436	500	487
Av. weaning type score				11.5	11.2	12.2
Av. weaning condition score				9.5	12.0	12.0
Were calves creep fed?	No	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.91	1.91	1.94	1.51	1.76	1.73

(1) Age of dam and sex

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Alabama Station

Location Line or group Breed of sire Breed of dam	Auburn Purebred Angus Angus	Auburn Purebred Hereford Hereford	Auburn Purebred Shorthorn Shorthorn	Auburn Crossbred Angus x Angus
BULLS, No.	9	9		
Av. initial age (days)	377	354		
Av. initial wt. (lbs.)	781	690		
Av. no. days on feed	140	140		
Av. final weight	1117	1003		
Av. daily gain	2.40	2.24		
Av. score	12.6	11.7		
Av. feed per day(1)	Group fed	Group fed		
STEERS, No.	3	13		4
Av. initial age (days)	624	624		315
Av. initial wt. (lbs.)	787	743		472
Av. no. days on feed	131	131		200
Av. final weight	1032	1008		836
Av. daily gain	1.87	2.02		1.82
Av. score				
Condition	11.7	11.6		12.2
Av. feed per day(1)	Group fed	Group fed		Group fed
HEIFERS, No.	13	18	4	6
Av. inbreeding (%)			5	
Av. initial age (days)	354	335	328	341
Av. initial wt. (lbs.)	484	466	466	425
Av. no. days on feed	132	132	132	132
Av. final weight	696	679	698	632
Av. daily gain	1.61	1.61	1.76	1.57
Av. score	11.8	11.0	12.8	10.5
Av. feed per day(1)	Group fed	Group fed	Group fed	Group fed

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Alabama Station

Location Line or group Breed of sire Breed of dam	Auburn Crossbreds Hereford x Hereford	Auburn Crossbreds Shorthorn Shorthorn	Auburn Crossbreds Angus Hereford	Auburn Crossbreds Angus Shorthorn
STEERS, No.	5	3		1
Av. initial age (days)	312	365		366
Av. initial wt. (lbs.)	422	407		525
Av. no. days on feed	200	200		200
Av. final weight	824	830		960
Av. daily gain	2.01	2.12		2.18
Av. score				
Condition	12.0			13.0
Av. feed per day	Group fed	Group fed	Group fed	Group fed
HEIFERS, No.	5	8	2	4
Av. inbreeding (%)		12.8		
Av. initial age (days)	333	331	334	327
Av. initial wt. (lbs.)	482	415	418	452
Av. no. days on feed	132	132	132	132
Av. final weight	728	638	630	671
Av. daily gain	1.86	1.69	1.61	1.66
Av. score	11.6	11.0	10.5	11.0
Av. feed per day	Group fed	Group fed	Group fed	Group fed

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Alabama Station

Location	Auburn	Auburn	Auburn	Auburn
Line or group	Crossbreds	Crossbreds	Crossbreds	Crossbreds
Breed of sire	Hereford	Hereford	Shorthorn	Shorthorn
Breed of dam	Angus	Shorthorn	Angus	Hereford
STEERS, No.	3	2	4	3
Av. initial age (days)	346	349	331	332
Av. initial wt. (lbs.)	455	584	508	493
Av. no. days on feed	200	200	200	200
Av. final weight	818	975	915	942
Av. daily gain	1.82	1.96	2.04	2.24
Av. score				
Condition	12.7	12.0	12.5	12.3
Av. feed per day	Group fed	Group fed	Group fed	Group fed
HEIFERS, No.		2	2	2
Av. initial age (days)		357	341	332
Av. initial wt. (lbs.)		466	476	488
Av. no. days on feed		132	132	132
Av. final weight		670	698	715
Av. daily gain		1.55	1.68	1.72
Av. score		11.5	12.0	12.0
Av feed per day		Group fed	Group fed	Group fed

ARK (1)

Arkansas Station

by

C. J. Brown

I. PROJECT: Hatch 170 (S-10)(AHRD d1-8)

Evaluation of Performance Records of Beef Cattle

II. OBJECTIVES:

A. Continue to develop practical but adequate methods for identifying, evaluating and propagating the genetic potential for the production of beef. This would involve determining the kind and number of performance records necessary to prove beef sires and dams as well as the proper use of records in planning matings.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and animals: During the year through a grant in aid an Aberdeen-Angus bull, "Kermac Marshall 36," was acquired to continue evaluation of popular blood lines within that breed. A polled Hereford bull which had one of the top records in the fall performance test and was sired by a bull consistently having high gaining sons was purchased from a cooperative breeder. One-half interest was also purchased in a polled Hereford bull which had one of the top performance records among the fall tested cattle on Ogeechee Farms. Through these purchases and replacements grown out the total number of animals available for study is 675. Cows and heifers of breeding age number 223 Aberdeen-Angus, 105 Herefords and 20 Shorthorns. An additional facility that will double as a sales arena and feed storage was completed. Pasture development was continued.

B. Research results: Analysis and evaluation of existing records were continued. Monthly weights and quarterly or semi-annual measurements were taken on 613 cattle. A total of 588 cattle were classified independently by four judges. Additional data were accumulated on the quantity and quality of milk from beef cows and nursing behavior patterns of cows and calves. Seventy-nine young bulls were individually fed to record gains and feed conversion. Fifteen of these bulls were further used in detailed digestion trials.

Least squares estimates of the effects of years and season of birth, sex, sire and age of dam on the weight of beef calves at 60, 120, 180 and 240 days of age are presented in table 1. Weight records of 893 calves were analyzed and studied separately

in three herds. The percentage of variance associated with these factors is listed in table 2. The size and statistical significance of differences and the percentage of variance associated with the five factors studied appear large enough to justify correction of weight records at these ages in the evaluation of breeding animals. These data indicate the need for consideration of age of calf and system of management in the standardization of calf weight records for sex, season of birth and age of dam. The development of correction factors for use under systems of management and environmental conditions similar to those under which they are to be applied is indicated.

IV. FUTURE PLANS:

Future plans are to continue collection of data and evaluation of records dealing with rate and efficiency of gain, visual appraisal, growth and development, mothering ability and reproduction according to project outlines.

V. PUBLICATIONS DURING THE YEAR:

Drewry, K. J., C. J. Brown and R. S. Honea. 1959 Relationships among factors association with mothering ability in beef cattle. J. Anim. Sci. 18:938-946.

Drewry, K. J. 1959. Relationships among factors associated with mothering ability in beef cattle. Masters Thesis. Univ. of Ark. Library.

Brown, C. J. and Elmer Krehbiel. 1959. An analysis of differences in weight of beef calves at 60, 120, 180 and 240 days of age. J. Anim. Sci. 18:1470 (abstract).

Brown, C. J. 1960. Using adjusted calf weights to evaluate beef cattle records. Ark. Farm Res. 9:1:5.

Brown, C. J. 1959. Correction factors when selecting for mothering ability in beef herds. Ark. Farm Res. 8:5:10.

Brown, C. J., Elmer Krehbiel, Warren Gifford, and Charles Mabry. 1960. Selection for type in a small herd of aberdeen-angus cattle. (Submitted as a Station bulletin).

Brown, C. J. 1959. The meaning of individual performance records. Ark. Agri. Exp. Sta. Special Report. No. 6 pp. 9-10.

Krehbiel, Elmer, C. J. Brown, Warren Gifford, and Charles Mabry. 1959. Effectiveness of selection for improved type in a beef cow herd. Ark. Agri. Exp. Sta. Special Report. No. 6 pp. 11, 13.

Drewry, K. J., C. J. Brown and R. S. Honea. 1959. Factors affecting weaning weights of beef calves. Ark. Agri. Exp. Sta. Special Report. No. 6 pp. 11, 12.

VI. PUBLICATIONS PLANNED:

Bulletin on Performance Testing of Bulls

Bulletin on Cow Performance.

Journal Paper on Relative Importance of Factors Affecting Preweaning Weights

Table 1

Least Square Estimates of the Influence of Year, Season, Sire Sex, and Age of Dam on Weight of Beef Calves

		HERD H							
Calf Age (days)		60		120		180		240	
Mean		165	7[a]	295	15	373	21	405	28
Year:	1950	--		--		--		--	
	1951	--		--		--		--	
	1952	-5	8	-38	17	-2	24	30	31
	1953	4	8	-30	16	-2	23	43	30
	1954	0	8	-19	16	33	24	48	31
	1955	0	8	-29	15	-31	22	-15	29
	1956	-3	5	-34	12	-30	17	-37	22
	1957	2	5	-22	11	0	16	8	21
	1958	0		0		0		0	
Season:	Fall(9,10,11)[b]	-11	3	-39	5	-66	8	-36	10
	Winter(12,1,2)	--		--		--		--	
	Spring(3,4,5)	0		0		0		0	
	Summer(6,7,8)	--		--		--		--	
Sires[c]		-3	5	-10	8	-18	12	-26	17
		15	6	16	10	17	14	21	18
		-21	7	-30	11	-43	15	-39	21
		-4	10	2	16	0	23	11	29
		0		0		0		0	
		-18	6	-25	9	-41	13	-36	17
		-25	6	-42	10	-65	15	-70	18
		-8	10	-4	16	14	25	47	37
		-2	6	-16	10	-15	15	-14	20
		-13	13	-40	22	-43	32	-52	41
		--		--		--		--	
Sex of Calf:									
Male		11	3	17	4	30	6	57	8
Female		0		0		0		0	
Lactation:	1st	-28	5	-37	8	-36	12	-30	16
	2nd	-11	5	-13	8	-17	12	-35	16
	3rd	-3	5	0	9	-6	12	-14	16
	4th	2	5	3	9	8	12	13	17
	5th	0		0		0		0	
	6th	1	6	3	10	6	15	26	20
	7th	-14	7	-27	11	-28	15	-29	21
	8th	-5	6	-2	10	17	15	18	19
No. calves		287		267		200		253	

[a]Standard error, values are ±
[b]Numbers following season name refer to months included
[c]Sires in each herd were used only in that herd

(cont.)

Table 1 (cont.)

Calf Age (days)	HERD A_1							
	60		120		180		240	
Mean	157	6[a]	252	9	366	13	427	16
Year: 1950	19	12	25	19	35	27	74	33
1951	3	7	17	12	0	17	15	22
1952	-4	7	19	11	17	15	36	19
1953	0	7	4	11	-8	15	6	20
1954	3	6	17	10	12	15	-2	18
1955	-1	6	11	9	-17	13	-34	17
1956	13	5	12	9	-6	13	-20	16
1957	6	6	8	10	-19	14	-34	18
1958	0		0		0		0	
Season: Fall(9,10,11)[b]	-12	3	-42	5	-64	7	-39	9
Winter(12,1,2)	--		--		--		--	
Spring(3,4,5)	0		0		0		0	
Summer(6,7,8)	--		--		--		--	
Sires[c]	-11	6	-21	9	-31	13	-38	16
	0	5	-10	8	-30	12	-54	15
	0	7	0	10	-3	15	8	17
	0	6	-6	8	-14	12	-18	16
	-9	6	-3	9	-3	13	23	29
	-21	7	-32	12	-47	16	-39	23
	-17	6	-27	9	-26	13	-24	17
	-6	6	-6	8	0	12	-2	15
	0		0		0		0	
	-1	13	13	19	8	28	-9	36
	15	7	--		--		--	
Sex of Calf:								
Male	8	2	12	4	18	5	33	7
Female	0		0		0		0	
Lactation: 1st	-17	5	-17	7	-14	10	-11	13
2nd	-6	5	-5	7	-2	10	2	13
3rd	4	5	3	8	9	11	10	14
4th	0	5	3	8	6	12	6	15
5th	0		0		0		0	
6th	0	6	6	10	10	14	34	18
7th	7	8	21	12	33	16	33	20
8th	-3	7	0	11	9	15	29	20
No. Calves	334		314		309		277	

[a]Standard error, values are ±
[b]Numbers following season name refer to months included
[c]Sires in each herd were used only in that herd

(cont.)

Table 1 (cont.)

Calf Age (days)		HERD A_2							
		60		120		180		240	
Mean		179	8[a]	245	12	353	17	394	20
Year:	1950	7	15	67	21	46	30	103	36
	1951	-3	15	42	21	23	30	79	36
	1952	0	13	48	18	32	26	86	32
	1953	0	12	47	17	45	24	79	30
	1954	4	10	27	14	15	20	31	24
	1955	-1	8	39	12	27	17	50	20
	1956	0	9	26	13	36	19	70	24
	1957	0	7	20	11	9	16	28	19
	1958	0		0		0		0	
Season:	Fall(9,10,11)[b]	-1	4	-12	5	-5	8	19	9
	Winter(12,1,2)	7	4	28	6	4	8	21	9
	Spring(3,4,5)	0		0		0		0	
	Summer(6,7,8)	-3	6	-12	8	-2	11	21	13
Sires[c]		-8	11	-32	15	-22	23	-43	27
		-2	9	-11	12	-13	18	-20	21
		-7	8	-19	10	-23	15	-22	19
		0		0		0		0	
		-29	11	8	16	-4	23	10	31
		1	8	-5	11	-12	17	-58	22
		-26	7	-11	11	-15	15	-7	19
		-10	10	4	13	5	19	-1	24
		5	11	20	16	30	24	25	30
		--		--		--		--	
		--		--		--		--	
Sex of Calf:									
Male		9	3	16	4	19	5	22	7
Female		0		0		0		0	
Lactation:	1st	-40	5	-52	7	-64	10	-74	12
	2nd	-26	5	-29	7	-36	10	-48	12
	3rd	-21	5	-21	7	-17	11	-18	13
	4th	-22	6	-22	8	-22	11	-32	14
	5th	0		0		0		0	
	6th	-10	6	5	9	9	12	-11	15
	7th	-9	7	3	10	0	15	6	19
	8th	-18	7	-11	10	-18	14	-20	17
No. Calves		272		272		252		209	

[a]Standard error, values are ±

[b]Numbers following season name refer to months included

[c]Sires in each herd were used only in that herd

Table 2

PERCENTAGE OF VARIANCE ASSOCIATION WITH YEAR, SEASON, SIRE SEX AND AGE OF DAM IN THE ANALYSIS OF WEIGHTS OF CALVES AT 60, 120, 180, AND 240 DAYS OF AGE

Age of Calf and Herd	Years	Seasons	Sires	Sex	Age of Dam	Remainder
60 Days						
H	a	5.5**	10.5**	7.7	14.3	62.1
A_1	2.1*	7.3**	5.5**	4.3**	8.0**	72.7
A_2	a	0.0	4.4**	7.0**	20.2**	68.1
120 Days						
H	1.8*	20.5**	7.8**	6.1**	9.5**	54.2
A_1	a	28.4**	3.2**	4.4**	3.4**	60.8
A_2	4.1**	15.4**	1.0	7.2**	20.0**	52.3
180 Days						
H	7.0**	25.2**	7.0**	8.0**	4.5**	48.4
A_1	2.0*	31.9**	2.8**	4.5**	1.8*	56.9
A_2	2.1	a	a	6.5**	22.5**	68.9
240 Days						
H	8.0 **	4.9**	5.1**	21.7**	4.8**	55.6
A_1	6.4 **	9.3**	3.4*	11.9**	1.6	67.3
A_2	6.0 **	1.6**	1.7	5.5**	20.9**	64.3

A_1 =Purebred Aberdeen-Angus maintained at Main Experiment Station, Fayetteville
A_2 =Purebred Aberdeen-Angus maintained at Livestock and Forestry Branch Station, Batesville
H = Purebred Hereford maintained at Main Experiment Station, Fayetteville.

* = Component calculated from a significant mean square, P<.05
** = Component calculated from a highly significant mean square, P<.01
a = Indicates that the variance component for the effect in that herd was negative and assumed to be zero.

PERFORMANCE OF COW HERDS. 1959 CALVES

Arkansas Station

Location Line or group Breed of sire Breed of dam	Main Sta. Fall Hereford Hereford	Main Sta. Fall Shorthorn Shorthorn	B. and F. Spring Angus Angus	L. and F. Fall Angus Angus
No. cows calving	41	8	30	24
No. calves raised	37	4	28	20
Av. inbr. of dams (%)	.018	.063	.002	.012
Av. inbr. of calves (%)	.033	.036	.023	.018
Av. birth date	10/10	11/20	2/27	9/28
Av. birth wt. (lbs.)	67.3	69.4	56.8	58.5
Av. weaning age (days)	189	188	180	187
Av. weaning wt. (lbs.)	303	268	352	375
Av. weaning type score			69	
Av. weaning condition score[2]			65	
Were calves creep fed?	No	No	Yes	Yes
Adjusted[(1)] av. daily gain from birth to weaning	1.19	1.06	1.77	1.84

[1]Corrected for sex and age of dam
[2]Scores are recorded on a scale ranging from 30 to 100, which allows 10 points for each classification grade of Excellent, Very Good, Good Plus, Good, Good Minus, Fair and Poor.

PERFORMANCE OF COW HERDS. 1959 CALVES

Arkansas Station

Location	Main Sta.	Main Sta.	Main Sta.	Main Sta.
Line or group	Spring	Spring	Spring	Fall
Breed of sire	Angus	Hereford	Shorthorn	Angus
Breed of dam	Angus	Hereford	Shorthorn	Angus
No. cows calving	39	35	12	59
No. calves raised	38	33	12	59
Av. inbr. of dams (%)	.013	.008	.000	.018
Av. inbr. of calves (%)	.039	.020	.080	.022
Av. birth date	3/13	3/9	3/11	10/16
Av. birth wt. (lbs.)	62.3	64.3	65.6	60.3
Av. weaning age (days)	188	194	191	180
Av. weaning wt. (lbs.)	390	356	351	289
Av. weaning type score	72	69	65	
Av. weaning condition score[2]	69	68	66	
Were calves creep fed?	No	No	No	No
Adjusted[(1)] av. daily gain from birth to weaning	1.60	1.47	1.50	1.23

[1]Corrected for sex and age of dam
[2]Scores are recorded on a scale ranging from 30 to 100, which allows 10 points for each classification grade of Excellent, Very Good, Good Plus, Good, Good Minus, Fair and Poor.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Arkansas Main Station
(Cattle from cooperating breeders)

Location Line or group Breed of sire[1] Breed of dam	Main Sta. Spring Charbray 1959	Main Sta. Spring Hereford	Main Sta. Spring Angus	Main Sta. Fall Hereford
BULLS, No.		3	6	6
Av. initial age (days)		265	240	255
Av. initial wt. (lbs.)		453	466	500
Av. no. days on feed		154	154	154
Av. final weight		844	760	844
Av. daily gain		2.54	1.91	2.28
Av. score				
Conformation		74	72	71
Condition		73	72	70
Av. feed per day(1)		17.72	15.80	17.96
Concentrates		11.81	10.54	11.98
Roughage		5.91	5.27	5.99
HEIFERS, No.	6			
Av. initial age (days)	253			
Av. initial wt. (lbs.)	565			
Av. no. days on feed	154			
Av. final weight	882			
Av. daily gain	2.06			
Av. score				
Conformation	72			
Condition	73			
Av. feed per day(1)	18.31			
Concentrates	12.20			
Roughage	6.10			

[1]Calves are individually fed a ration of 1/3 roughage, 2/3 grain

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Arkansas Station

Location Main Sta. and Line or group Breed of sire Breed of dam	Batesville Spring Angus Angus	Main Sta. Spring Hereford Hereford	Main Sta. Fall Shorthorn Shorthorn	Main Sta. Fall Angus Angus	Main Sta. Fall Hereford Hereford
BULLS, No.	20	12	1	25	6
Av. inbreeding (%)	.079			.035	.014
Av. initial age (days)	241	243	165	220	216
Av. initial wt. (lbs.)	422	409	347	407	386
Av. no. days on feed	154	154	154	154	154
Av. final weight	738	734	605	689	707
Av. daily gain	2.05	2.11	1.68	1.83	2.09
Av. score					
Conformation	68	69	71	70	69
Condition	69	70	66	69	69
Av. feed per day(1)	16.51	15.07	13.27	15.13	16.11
Concentrates	11.00	10.05	8.84	10.09	10.74
Roughage	5.50	5.02	4.42	5.04	5.37
HEIFERS, No.	6	6			
Av. inbreeding (%)	.131	.080			
Av. initial age (days)	243	242			
Av. initial wt. (lbs.)	409	426			
Av. no. days on feed	154	154			
Av. final weight	643	664			
Av. daily gain	1.52	1.55			
Av. score					
Conformation	75	72			
Condition	73	73			
Av. feed per day(1)	15.12	14.00			
Concentrates	10.08	9.34			
Roughage	5.04	4.67			

[1]Calves are individually fed a ration of 1/3 roughage, 2/3 grain

DATA ON ANIMALS SLAUGHTERED

Arkansas Station

Location	Main Sta.	Main Sta.	Main Sta.	Main Sta.
Herd	Angus Spring	Hereford Spring	Angus Fall	Hereford Fall
Breed of sire	Angus	Hereford	Angus	Hereford
Breed of dam	Angus	Hereford	Angus	Hereford
Sex	Males	Males	Males	Males
No. slaughtered	13	3	14	5
Age at slaughter (days)	472	481	399	375
Time in feedlot (days)	154	154	154	154
Gain in feedlot (lbs.)	297.8	273	273	310.3
Final feedlot weight	698	636	667.6	707.0
Slaughter weight(1)	784.3	741	691.1	595.6
Carcass weight(2)	430.3	410.7	370.3	328
Dressing percentage(3)	54.9	55.4	53.6	55.1
Fat thickness over rib eye (ins.)	9.97	9.23	9.37	7.15

[1]These are bulls slaughtered soon after the end of performance test, continued at same level of feed.
[2]Chilled carcass weight
[3]Slaughter weight/chilled carcass weight equals dressing percentage

Ona, Florida Station

-by-

W. G. Kirk

I. PROJECT: 615

Influence of Breed Composition and Level of Nutrition on Adaptability of Cattle to Central Florida Conditions. W. G. Kirk, E. M. Hodges, F. M. Peacock, J. E. McCaleb and M. Koger

II. OBJECTIVES:

Relative productivity of Shorthorn and Brahman cows and their crosses when kept under pasture conditions to supply low, medium and high nutrition levels throughout the year.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Sixty cows in each of three herds, each herd consisting of the following cows:

10 Brahman	
10 3/4Br-1/4Sh	
10 1/2Sh-1/2Br	bred to Brahman bull
10 1/2Sh-1/2Br	
10 3/4Sh-1/4Br	
10 Shorthorn	bred to Shorthorn bull

B. Three pastures as follows:

Herd 1.	800 acres native range.
Herd 2.	315 acres native range and 75 acres improved pasture.
Herd 3	75 acres pangola pasture, 20 acres of which overplanted with white clover and irrigated.

C. Herd 1. 64% weaned calf crop with an av. 205-day weight of 300 lbs.
Herd 2. *49% weaned calf crop with an av. 205-day weight of 366 lbs.
Herd 3. 75% weaned calf crop with an av. 205-day weight of 421 lbs.

*1957-58 winter was severe and cows in Herd 2 were extremely thin during the 1958 breeding season, resulting in the lowest calf crop since this pasture was established.

IV. FUTURE PLANS:

In 1961 switch Shorthorn and Brahman bulls, using a criss cross breeding program.

V. PUBLICATIONS DURING THE YEAR:

None.

VI. PUBLICATIONS PLANNED:

Dr. W. L. Reynolds used the records from this project and other records of calves produced here since 1944 for his Ph.D. thesis, "Genetic and Environmental Influences Affecting Birth Weights, Weaning Data and Reproductive Performance in Beef Cattle."

Several publications will be prepared.

* * * * * * * * *

I. PROJECT: 390 (S-10)

Breeding Beef Cattle for Adaptation to Florida. W. G. Kirk and F. M. Peacock.

II. OBJECTIVE:

Shorthorn-Brahman crosses as foundation animals for commercial beef production.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Number of Brahman females increased. No change in facilities.

B. Research results from 1942 to 1948 given in a manuscript entitled, "Genetic and Environmental Influences of Weaning Weight and Slaughter Grade of Brahman, Shorthorn and Brahman-Shorthorn Crossbred Calves." F. M. Peacock, W. G. Kirk, E. M. Hodges, W. L. Reynolds and M. Koger. This manuscript has been approved and will be published shortly.

IV. FUTURE PLANS:

Continue with present plans.

* * * * * * * * * * *

I. PROJECT: Proposed State Project

Performance of Charbray, Charolais-Brahman and Charolais-Shorthorn Crosses under Florida Conditions. F. M. Peacock and W. G. Kirk.

II. OBJECTIVES:

Value of Charolais-Brahman and Charolais-Shorthorn crosses for commercial beef production.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Six Charbray (3/4Charolais-1/4 Brahman) and two 1/2 Charolais-1/2 Brahman beifers were purchased in 1960. These eight cattle plus eleven Brahman and ten Shorthorn females bred to a Charolais bull in 1960. Weaning and post-weaning data to be obtained on all calves.

IV. FUTURE PLANS:

Expect to purchase additional Charbray females in 1960-61 fiscal year.

DATA ON ANIMALS SLAUGHTERED

Range Cattle Station, Ona, Florida

Location	Ona, Florida		
Herd	Project Nos. 390 and 615		
Breed of sire	Shorthorn	Shorthorn	Brahman
Breed of dam	Brahman	1/2Sh-1/2Br	1/2Sh-1/2Br
Sex	Steers	Steers	Steers
No. slaughtered	4	4	4
Age at slaughter(mos.)	13	14	13 1/4
Time in feedlot (days)	182	182	182
Av. gain in feedlot (lbs.)	321	354	321
Av. final feedlot weight	796	860	835
Slaughter weight(1)	772	834	810
Carcass weight(2)	469	500	521
Dressing percentage(3)	60.75	59.99	62.65
Slaughter grade	10	11	10
Carcass grade	8	9	8.5
Other observations on carcass:	All cattle graded low in carcass because of lack of marbling.		

(1) Weighed 8:00 a.m.; trucked to Gainesville, 200 miles, weighed, slaughtered next morning.
(2) Cold weight - 2.5% of warm carcass deducted.
(3) Live weight at Range Station minus 3% and shrunk carcass weight.

PERFORMANCE OF COW HERDS. 1959 CALVES*

Range Cattle Experiment Station

Location	Ona, Florida					
Line or group	Project Nos. 390 and 615					
Breed of sire	Brahman	Brahman	Brahman	Shorthorn	Shorthorn	Shorthorn
Breed of dam	Brahman	3/4Br-1/4Sh	1/2Sh-1/2Br	1/2Sh-1/2Br	3/4Sh-1/4Br	Shorthorn
No. cows calving	28	30	26	28	18	29
No. calves raised	14	19	24	19	10	17
Av. weaning age	223	222	216	224	202	224
Av. weanign wt.	361	417	458	422	334	293
Av. weaning type score	9.7	10.1	10.5	11.1	10.3	10.5
Av. weaning condition score	8.2	8.9	9.0	10.0	8.1	8.4
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.49	1.67	1.91	1.75	1.48	1.21

*Averages shown are the unweighted means for pasture programs.

Fla (1)

Gainesville, Florida
Station

-by-

Marvin Koger

I. PROJECT: Anim. Husb. 752 (S-10)(AHRD d1-34)

Genetics of Dwarfism in Beef Cattle.

II. OBJECTIVES:

A. To characterize the various types of dwarfism in beef cattle in Florida.

B. To investigate the genetic relationship between the more prevalent types of dwarfism.

C. To determine the influence of genetic environment on expression of the snorter dwarf gene.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Results from test matings confirmed previous indications that certain carriers of the snorter gene and snorter dwarf animals when mated to normal appearing animals produce a high frequency of "comprest" type offspring of such matings are more compact in type than animals in dwarf-free populations. A dwarf bull mated to cows of normal phenotype sired 1 dwarf, 2 "comprest" and 2 "normal" offspring. Eight guinea and midget cows mated to this same bull produced 2 "normal" and 6 "comprest" type females, which appear more extreme in type than their dams. An Angus carrier of the snorter gene mated to normal cows produced 3 "normal" and 1 "comprest" offspring.

B. A guinea bull mated to a purebred Hereford of the "comprest" type resulted in a typical Dexter type bulldog monster. This suggests that the "comprest" Hereford may be a carrier of the Dexter gene. Whether "comprest" Herefords descending from Colorado Domino 118 are genetically the same as "comprests" sired by dwarf and carrier bulls is not known.

C. Investigations on the excretion of certain metabolic products by animals of known genotypes were initiated in cooperation with the Medical School.

IV. FUTURE PLANS:

Further critical test matings of various dwarfs and dwarf carriers will be made. If encouraging results continue from the preliminary studies on excretion of certain metabolic products, this work will be expanded.

V. PUBLICATIONS DURING THE YEAR:

Dollahon, J. C., M. Koger, J. F. Hentges and A. C. Warnick. The productivity of snorter dwarf-carrier and non-carrier Hereford cattle. Manuscript ready for submitting to J. Anim. Sci.

Two of the three manuscripts listed last year have appeared in scientific journals. The third will appear in the next issue of the Journal of Heredity.

PERFORMANCE OF COW HERDS. 1959 CALVES

Florida, Beef Research Unit Station

Location Line or group* Breed of sire Breed of dam	British A and H Gr. A. Gr. H.	A x H A and H Crossbred	A x B A and B Crossbred	H x SG H and SG Crossbred
No. cows calving	53	11	37	42
No. calves raised	46	11	32	33
Av. weaning age	217	202	210	206
Av. weaning wt.	406	366	409	407
Av. weaning type score	11.0	12.0	9.6	10.3
Av. weaning condition score	9.0	10.0	8.7	9.0
Were calves creep fed?	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.66	1.65	1.78	1.79

*Foundation cows for all programs were Brahman-native cows. All groups are still in formative stage. British = Cows upgraded to British from Brahman-native cows, A x H = Criss cross between Angus and Hereford, A x B = Criss cross between Angus and Brahman, H x SG = Criss cross between Hereford and Santa Gertrudis.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958

Location	-----Florida, Beef Research Unit Station-------			
Line or group	British	A x H	A x B	H x SG
Breed of sire	A x H	A and H	A and B	H and SG
Breed of dam	Gr. A or H	Crossbred	Crossbred	Crossbred
Sex	Female	Female	Female	Female
Number	8	14	7	21
Initial				
Date	8-20-58	8-20-58	8-20-58	8-20-58
Age (days)	217	210	202	206
Weight (lbs.)	418	445	467	468
Score				
Condition	9.3	10.0	10.9	10.3
First period				
Feeding regime	Pasture plus limited supplement from November to March.			
Final				
Date	8-19-59	8-19-59	8-19-59	8-19-59
Age	582	575	567	571
Weight	675	722	735	743
Score				
Condition	8.3	8.6	8.4	7.5
Gain per day of age	1.16	1.26	1.30	1.30

Br. Fla. (1)

Brooksville, Florida Station

-by-

W. C. Burns

I. PROJECT: Anim. Husb. 629 (S-10)(AHRD dl-5)

Selection of Cattle for Beef Production in the Southeastern United States

II. OBJECTIVES:

To improve the reproductive efficiency and meat producing qualities of different strains of cattle under Florida conditions. To test various breeding systems with these cattle and to determine if combining ability will provide a means of increasing the rate of improvement by cross-progeny testing.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. A 40 x 72' hay shed was installed making two of these sheds.

B. Self-feeding hay racks were installed in most of the pastures

C. Two miles of fence erected at Turnley area.

D. One and one-half miles of fence erected at the LU area.

E. Set of pens started at the LU area

F. Some new equipment was acquired and at the present time, the equipment and physical facilities are in good condition.

G. Cattle acquired during the year were 13 Hereford and 6 Angus calves. There are now 284 animals of breeding age and 87 yearling heifers.

IV. FUTURE PLANS:

Continue expansion and development of the Turnley area for the combining ability study and the LU area for expanding our present purebred herds.

V. PUBLICATIONS DURING THE YEAR:

Burns, W. C., M. Koger, A. C. Warnick and C. M. Kincaid. 1953-1958. Beef Cattle Production at West Central Florida Experiment Station, Brooksville, Florida.

Burns, W. C., M. Koger, A. Z. Palmer and C. M. Kincaid. 1957-1958. The Effect of Breed, Alfalfa leaf meal and stilbesterol implantation on steers at West Central Florida Experiment Station.

Annual Report

Bull Feeding Report.

VI. PUBLICATIONS PLANNED:

The Value of Creep Feeding at West Central Florida Experiment Station

Progress Report on the Value of Adding Sawdust to a Protein Supplement to control feed intake when self-fed.

DATA ON ANIMALS SLAUGHTERED

Location	Brooksville, Florida				
Herd	Angus	Brahman	B-Angus	Hereford	S.Gert.
Breed of sire	Angus	Brahman	B-Angus	Hereford	S.Gert.
Breed of dam	Angus	Brahman	B-Angus	Hereford	S.Gert.
Sex	Steer	Steer	Steer	Steer	Steer
No. slaughtered	8	4	8	8	8
Age at slaughter (mos)	18	18	18	18	18
Time in feedlot (days)	140	140	140	140	140
Gain in feedlot (lbs.)	2265	1373	2541	2560	3123
Final feedlot weight	778	858	942	779	1007
Slaughter weight[1]					
Carcass weight[2]	430.7	500.0	550.7	442.0	585.7
Dressing percentage[3]	56.92	58.18	58.46	56.67	58.14
Slaughter grade	11.6	9.5	10.2	10.0	7.1
Carcass grade	10.1	8.0	9.2	8.7	7.9
Rib eye area (sq. in.)	8.8	8.1	10.5	8.4	10.6
W-B Shear					
Core size	1/2"	1/2"	1/2"	1/2"	1/2"
Shear Force (lbs.)	10.4	12.7	11.1	10.6	10.7

(1) Cattle were weighed one morning, shipped and slaughtered next morning without feed.
(2) Hot weight and shrunk 3%.
(3) The final weight and warm carcass weight.

PERFORMANCE OF COW HERDS. 1959 CALVES

Brooksville, Florida Station

Location	Brooksville, Florida						
Line or group	Angus	Brahman	B-Angus	B-Angus	Hereford	S.Gert.	SG x RP
Breed of sire	Angus	Brahman	B-Angus	Angus	Hereford	S.Gert	S.Gert
Breed of dam	Angus	Brahman	B-Angus	B-Angus	Hereford	S.Gert.	SG x RP
No. cows calving	45	20	30	29	28	28	7
No. calves raised	42	16	24	29	23	25	7
Av. birth date	1-26-59	2-4-59	2-14-59	1-26-59	1-17-59	2-20-59	1-24-59
Av. birth wt. (lbs.)	59.6	61.4	62.5	61.7	67.9	65.4	72.0
Av. weaning age	221	212	202	221	230	208	223
Av. weaning wt.	386.4	398.8	384.4	444.5	433.0	484.4	468.8
Av. weaning condition score	9.4	8.8	8.6	9.7	10.4	10.3	9.1
Were calves creep fed?(2)							
Adjusted av. daily gain from birth to weaning(1)	1.59	1.66	1.69	1.73	1.70	2.05	1.96

(1) Adjusted for sex and age of dam.
(2) One-half of the calves in each group were creep fed.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Brooksville, Florida Station

Location	Brooksville, Florida				
Line or group	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of sire	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of dam	Angus	Brahman	B-Angus	Hereford	St. Gert.
BULLS, No.	14	5	9	8	7
Av. initial age (days)	291	290	275	301	283
Av. initial wt. (lbs.)	510	487	526	495	550
Av. no. days on feed	140	140	140	140	140
Av. final weight	777	766	822	791	870
Av. daily gain	1.9	2.0	2.1	2.1	2.6
Av. score					
Conformation	9.5	8.4	8.0	9.8	8.6
Condition	9.0	8.0	8.0	9.0	9.0
Av. feed per day(1)					
Concentrates					
Roughage					
STEERS, No.	4	3	14	5	9
Av. initial age (days)	278	265	274	256	283
Av. initial wt. (lbs.)	429	397	468	442	530
Av. no. days on feed	126	126	126	126	126
Av. final weight	490	495	522	480	594
Av. daily gain	.48	.78	.43	.30	.51
Av. feed per day(1)					
Concentrates					
Roughage					
HEIFERS, No.	11	6	35	22	27
Av. initial age (days)	267	257	264	291	280
Av. initial wt. (lbs.)	407	422	455	440	503
Av. no. days on feed	126	126	126	126	126
Av. final weight	464	504	509	482	571
Av. daily gain	.45	.65	.43	.33	.54

(1) Bulls were lotted in different lots with other bulls and fed 2% body weight in concentrate plus hay free choice. Steers and heifers were run together on pasture on three different wintering levels testing two different levels of alfalfaleaf meal. All calves received six (6) lbs. concentrate per day plus hay free choice.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958
(1957 Heifers)

Location	Brooksville, Florida				
Line or group	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of sire	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of dam	Angus	Brahman	B-Angus	Hereford	St. Gert.
Sex	Heifer	Heifer	Heifer	Heifer	Heifer
Number	11	9	17	12	8
Initial					
Date	3-6-58	3-6-58	3-6-58	3-6-58	3-6-58
Age (days)	420	402	409	407	400
Weight (lbs.)	470.1	469.8	505.7	448.3	565.2
Score					
Conformation > Condition	Heifers were not graded in the spring				
First period >	All heifers run together in pasture during this period without supplement				
Final					
Date	8-18-58	8-18-58	8-18-58	8-18-58	8-18-58
Age	585	567	574	572	565
Weight	600.2	633.1	649.3	593.0	711.1
Score					
Conformation	10.3	9.3	9.3	10.0	8.4
Condition	6.6	6.8	6.6	6.6	6.2
Gain per day of age	1.02	1.12	1.13	1.04	1.26

(1957 Steers)

Location	Brooksville, Florida				
Line or group	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of sire	Angus	Brahman	B-Angus	Hereford	St. Gert.
Breed of dam	Angus	Brahman	B-Angus	Hereford?	St. Gert.
Sex	Steer	Steer	Steer	Steer	Steer
Number	9	5	12	9	9
Initial					
Date	10-31-57	10-31-57	10-31-57	10-31-57	10-31-57
Weight (lbs.)	389.9	387.0	463.1	379.0	496.0
Final					
Date	3-6-58	3-6-58	3-6-58	3-6-58	3-6-58
Weight	484.2	488.3	553.8	442.2	596.2

GA (1)

Georgia Station

-by-

W. C. McCormick

I. PROJECT: (S-10)(AHRD d1-3).

Selection of Beef Cattle for Single Items of Importance in Profitable Beef Production.

II. OBJECTIVES:

A. To obtain preliminary information on the relative effectiveness of selecting for a single character.

B. To observe trends in characters for which no selection is made when selection is for a single character.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Four herds of 50 Grade Polled Hereford breeding females each have been established at the Georgia State Prison Farm at Reidsville. In three herds selection of replacements is based on (1) weaning weight, (2) rate of post-weaning gain and (3) weaning score. For the fourth or average, herd replacements are selected whose records are nearest average for each trait. Bulls for these herds are selected from the breeding groups at Tifton.

B. During the 1958 breeding period, approximately 30 females in each herd were mated. The average performance of calves in these herds was as follows:

Herd	No. Calves	Av. Birth Weight	ADG-Birth to weaning	Weaning Scores Type	Weaning Scores Condition	Rate of Gain post-weaning
"Wean Weight"	28	72.6	1.67	10.6	8.9	0.92
"Rate of Gain"	29	62.7	1.65	10.0	8.5	0.97
"Score"	28	66.6	1.55	9.5	7.9	0.95
"Average"	26	67.3	1.63	9.9	8.5	0.97

C. Records of all calves were used in all calculations except rate of post-weaning gain. Only the heifer calves (10 to 13 per herd) were used in these calculations. The calves were born from January to March and weaned September 28 to October 6. Rate of post-weaning gain was calculated for the period beginning at weaning and ending April 5.

IV. FUTURE PLANS: Continue project as outlined.

V. PUBLICATIONS DURING THE YEAR: Routine Annual Reports

VI. PUBLICATIONS PLANNED: None.

I. PROJECT: (S-10)(AHRD d1-3).

Improvement of Beef Cattle Through Breeding

II. OBJECTIVES:

To performance and progeny test beef cattle.

III. ACCOMPLISHMENTS DURING THE YEAR:

The Polled Hereford herd of approximately 100 breeding females and the Angus herd of 40 breeding females are entered in this project. During the fall and winter of 1959, 32 Polled Hereford and 11 Angus bulls completed the pre-post-weaning test. The Polled Herefords were by five sires while the Angus were by two sires.

The data obtained from these animals was as follows:

Breed	Sire	No. calves	Weaned wt.	Post-weaning daily gain	Av. final age, days	Wt/day of age	Type Score
Polled Hereford	310	10	413	2.64	388	2.10	10[illegible]
Polled Hereford	452	9	478	3.10	380	2.47	11[illegible]
Polled Hereford	668	6	489	2.90	405	2.33	11[illegible]
Polled Hereford	710	2	470	2.49	397	2.19	10[illegible]
Polled Hereford	721	5	447	2.99	372	2.42	11[illegible]
Angus	W136	5	382	2.51	382	2.09	11[illegible]
Angus	233	6	408	2.68	396	2.14	10[illegible]

IV: FUTURE PLANS:

This project is being revised. The Polled Hereford herd will be divided into two groups. Approximately 40 percent of the inferior or untried cows will be mated to prospective herd bulls. These animals will be progeny tested and in the future such tests will include carcass evaluations. Such information will also be accumulated on the Angus herd within the next few years.

V. PUBLICATIONS DURING THE YEAR: Routine annual reports.

VI. PUBLICATIONS PLANNED: None.

I. PROJECT: Anim. Husb. 209 (S-10)(AHRD dl-3)

A Study of Grading, Crisscrossing, and Rotational Crossing as Breeding Systems for Commercial Beef Production

II. OBJECTIVES:

A. To study the relative value of grading, crisscrossing, and rotational crossing as breeding systems for commercial beef production.

B. To study heterotic effects in crosses between Angus and Polled breeds as compared to heterosis in crosses between these breeds and Santa Gertrudis, a breed based partially on a Brahman foundation.

C. To study the comparative value of the Santa Gertrudis breed with the Angus and Polled Hereford breeds.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. The following herds of animals were established at the Georgia State Prison from animals born in 1954 to 1957. The three grade and crisscross herds contain approximately forty breeding females while the rotational herd has sixty females. The calves were born primarily in January, February, and March. All were weaned from September 28 to October 10. During breeding season they were divided into bull units; thereafter, they were managed in larger groups.

B. Data recorded for the 1959 calf crop was as follows:

				Weaning Information				
Herd	Breeding System	No. calves	Av. birth wt.	Age, days	Wt.	ADG to Weaning	Type score	Condition score
Gr. A.	Grading up	26	60.7	233.3	425.8	1.56	10.0	9.0
Gr. P.H.	Grading up	22	71.8	228.0	410.3	1.48	10.1	8.8
Gr. S.G.	Grading up	28	77.6	231.8	542.9	2.02	8.8	8.6
A x P.H.	Crisscrossing	28	67.4	235.2	449.4	1.63	10.1	9.0
A x S.G.	Crisscrossing	19	73.5	218.8	467.8	1.80	9.0	8.5
P.H. x S.G.	Crisscrossing	27	72.1	220.1	480.2	1.86	9.4	9.1
AxP.H.xS.G.	Rotational Crossing	36	70.9	232.8	485.4	1.78	9.1	8.7

IV. FUTURE PLANS:

Studies will be continued. Second generation replacements will be selected as rapidly as possible.

V. PUBLICATIONS DURING THE YEAR: Routine annual reports.

VI. PUBLICATIONS PLANNED: A summary of the data after the 1960 calves are weaned.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING (or pastured for high gains)

Georgia Coastal Plain Experiment Station

Location	Tifton	Tifton
Line or group	Angus	P.Hereford
Breed of sire	Angus	P. Hereford
Breed of dam	Angus	P. Hereford
BULLS, No.	16	23
Av. initial age (days)	254	249
Av. initial wt. (lbs.)	498	507
Av. no. days on feed	140	140
Av. final weight	833	875
Av. daily gain	2.39	2.63
Av. score		
Conformation	11.8	12.0
Condition	11.4	11.2
Av. feed per day(1)	19.4	19.5
Feeding regime	A.M. only	A.M. only
HEIFERS, No.	14	21
Av. initial age (days)	260	255
Av. initial wt. (lbs.)	470	462
Av. no. days on feed	140	140
Av. final weight	678	713
Av. daily gain	1.49	1.79
Av. score		
Conformation	11.5	12.2
Condition	10.4	10.6
Av. feed per day(1)	13.26*	13.26*
Concentrates	10.04	10.04
Roughage	3.22	3.22

(1) Bulls fed ground and mixed ration composed of 1050 lbs. snapped corn, 200 lbs. oats, 100 lbs. molasses, 300 lbs. cottonseed meal, 100 lbs. alfalfa leaf meal, and 250 lbs. Coastal Bermuda hay.

* Angus and P. Hereford heifers fed and grazed as a group. Fed amounts shown in dry lot for 66 days. Remaining 74 days grazed on winter pasture and five pounds snapped corn per head daily.

PERFORMANCE OF COW HERDS. 1959 CALVES

Georgia Coastal Plain Experiment Station

Location	Reidsville, Georgia						
Line or group	Gr. A.	Gr. P.H.	Gr. S.G.	A x P.H.	A x S.G.	P.H.xS.G.	AxPHxS.G.
Breed of sire	A.	P.H.	S.G.	A,P.H.	A, S.G.	PH, S.G.	A,PH,S.G.
Breed of dam	Gr. A.	Gr. PH	Gr. S.G.	A x PH	A x S.G.	PH x S.G.	AxPHxS.G.
No. cows calving	26	22	28	28	19	28	36
No. calves raised	25	22	27	28	18	27	35
Av. birth date	2-10-59	2-16-59	2-10-59	2-11-59	2-24-59	2-23-59	2-10-59
Av. birth wt. (lbs.)	60.7	71.8	77.6	67.4	73.5	72.1	70.9
Av. weaning age	233.3	228.0	231.8	235.2	218.8	220.1	232.8
Av. weaning wt.	425.8	410.3	542.9	449.4	467.8	480.2	485.4
Av. weaning type score	10.0	10.1	8.8	10.1	9.0	9.4	9.1
Av. weaning condition score	9.0	8.8	8.6	9.0	8.5	9.1	8.7
Were calves creep fed?	No	No	No	No	No	No	No

Location	Reidsville	Reidsville	Reidsville	Reidsville	Tifton	Tifton	
Line or group	"Rate of Gain"	"Type"	"Wean wt."	"Average"	Angus	P.Hereford	
Breed of sire	P.Hereford	P.Hereford	P.Hereford	P.Hereford	Angus	P.Hereford	
Breed of dam	Gr.P.Herf.	Gr.P.Herf.	Gr.P.Herf.	Gr.P.Herf.	Angus	P.Hereford	
No. cows calving	27	29	28	26	33	75	
No. calves raised	26	27	28	23	29	69	
Av. birth date	2-10-59	2-12-59	2-18-59	2-1-59	2-4-59	2-7-59	
Av. birth wt. (lbs.)	62.7	66.6	72.6	67.3	58.2	66.5	
Av. weaning age	238.0	235.9	230.5	246.6	224.4	221.4	
Av. weaning wt.	466.0	432.0	457.1	470.8	403.3	440.1	
Av. weaning type score	10.0	9.5	10.6	9.9	10.6	10.9	
Av. weaning condition score	8.5	7.9	8.9	8.5	9.7	9.5	
Were calves creep fed?	No	No	No	No	Yes	Yes	

KY (1)

Kentucky Station

by

N. W. Bradley, D. G. Steele, W. Y. Varney and J. D. Kemp

I. PROJECT: Anim. Husb. 260 (S-10)

A Performance and Progeny Testing Program for Bulls of the Beef Breeds

II. OBJECTIVES:

Tu use rate of gain, efficiency of gain, conformation score and condition score of bull calves in an effort to determine the values these items should receive in predicting the future value of bulls in the breeding herd.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Sixteen stalls with small outside paved lots are used twice each year to text a total of 32 bulls for rate of gain and efficiency of feed utilization. Additional stalls are used for individually feeding the progeny of bulls which have completed the performance test. High gaining and low gaining bulls are bred to 20 grade Hereford and 20 purebred Red Poll cows. The calves from these matings are evaluated relative to sire performance as well as breed differences. Nineteen purebred Hereford heifers with a performance testing background are now available for use in the project. These heifers will be used to further evaluate the sires' effect on preweaning and postweaning performance and carcass characteristics. The Meats Laboratory at the University of Kentucky is available for collecting slaughter and carcass data.

B. The beef bull performance test was continued in the usual manner. Two 154-day performance tests which included a total of 30 bulls were conducted during the year. The 30 bulls consist of 6 Angus, 7 Shorthorns and 17 Herefords. Results were similar to those of previous tests inasmuch as considerable variability was observed in the different traits which were measured.

C. Twelve Hereford and 15 Red Poll x Hereford calves sired by two performance tested bulls were dropped at the Mercer farm during the winter and early spring. Tables 1 and 2 show the preweaning performance and carcass characteristics, respectively, of these calves as they were affected by sire. The data presented in Tables 1 and 2 indicate that there are no significant differences in either preweaning performance or carcass characteristics. These results are in agreement with those of the two previous years. Even though the difference in gaining ability of the sires is not great, it is felt that the expression of differences in inherent gaining ability of the calves may be masked by differences in mothering ability of the cows. Since the performance of previous calves is now known, it is hoped that the cow groups can be equalized with respect to their ability to influence their calves' gain.

D. Tables 3 and 4 present the data for the Mercer calves relative to breed differences. The comparisons are for 12 Hereford calves and 15 Red Poll x Hereford crossbred calves. The Red Poll x Hereford calves were 11 pounds heavier at birth and about 115 pounds heavier at weaning. As indicated by their heavier weaning weight, crossbred calves gained about 0.4 pound a day faster than Hereford calves. Although the committee overestimated the slaughter grades of the calves, the crossbred calves averaged one-third of a grade higher on both slaughter grade and U. S. carcass grade. As usual, the Herefords were scored slightly higher on feeder grade. The largest differences in the data presented in Table 4 are for carcass grade and dressing percent which favor the Red Poll x Hereford calves. This is the third year in which the Red Poll x Hereford calves have out-performed the Hereford calves. They have also yielded carcasses which were equal or superior to those from Hereford calves.

IV. FUTURE PLANS:

A. Two 154-day performance tests for young beef bulls will be conducted each year.

B. Thirty-six calves sired by high and low gaining Hereford bulls and out of Hereford and Red Poll cows will be weaned during the fall of 1960. Part or all of these calves will be individually fed a fattening ration for a sufficiently long period to obtain high good to low choice finish. Both preweaning and postweaning feed lot performance will be collcted for all of the calves. Detailed carcass information will be collected and analyzed according to sire and breed.

C. Detailed plans for a purebred herd of Hereford cows at the Eden Shale Farm are incomplete. However, this herd will be used to further evaluate the effect of sire on performance and carcass characteristics.

V. PUBLICATIONS DURING THE YEAR:

Bradley, N. W., A. R. Parsons and D. G. Steele. Performance and progeny testing of beef bulls. Annual Livestock Field Day, University of Kentucky Animal Husbandry Mimeo. July 15, 1959.

VI. PUBLICATIONS PLANNED:

Results will be published annually in the Kentucky Livestock Field Day Report and elsewhere as justified.

Table 1. Effect of Sire on the Preweaning Performance of Calves

No. of calves	Age, days	Final weight	A.D.G.	Adjusted[1] A.D.G.	Lbs./ day of age	Feeder grade	Carcass grade
High gaining sire[2]							
11	265	577	1.89	2.01	2.18	10.1	8
Low gaining sire[3]							
16	257	545	1.83	1.97	2.14	9.9	8

[1]Adjusted for sex of calf, age of dam and season of birth.
[2]A.D.G. on 154-day performance test - 2.55 pounds. Pounds per day at end of test - 2.40.
[3]A.D.G. on 154-day performance test - 2.26 pounds. Pounds per day of age at end of test - 2.34.

Table 2. Effect of Sire on Carcass Characteristics of Calves Slaughtered at Weaning

	SIRE Low Gainer	SIRE High Gainer
Number of calves	16	11
Carcass grade	8	8
Dressing percent	57.1	57.8
48-hour cooler shrink, %	2.17	2.13
Fat thickness over rib eye area, inches	.38	.34
Rib eye area, inches	6.65	7.43
Rib eye area, sq. in. per cwt. carcass	2.21	2.24
W-B shear, lbs. force[1]	21.3	22.2
9-10-11 rib section		
% fat	28.39	29.50
% lean	52.26	51.72
% bone	18.31	17.82
Marbling score[2]	10.37	10.36
Color fat[3]	2.00	2.00
Color lean[4]	3.31	2.73

[1]1-inch cores
[2]10 = traces, 11 = prectically devoid
[3]2 = yellowish tinge
[4]Munsell color paddles - the smaller the number the lighter the color.

Table 3. Preweaning Performance of Red Poll x Hereford and Hereford Calves

	Hereford	Red Poll x Hereford
Number of calves	12	15
Birth weight	71	82
Age, days	260	260
Final weight	495	609
Average daily gain	1.63	2.04
Slaughter grade	9.2	10.5
Carcass grade	7.8	8.7
Feeder grade	10.3	9.7

Table 4. Carcass Characteristics of Red Poll x Hereford and Hereford Calves Slaughtered at Weaning

	Hereford	Red Poll x Hereford
Number of calves	12	15
Carcass grade	7.8	8.7
Dressing percent	55.7	58.7
48-hour cooler shrink, %	2.30	1.96
Fat thickness over rib eye area, inches	.33	.39
Rib eye area, inches	6.18	7.59
Rib eye area, sq. inches per cwt. carcass	2.33	2.20
W-B shear, lbs. force[1]	21.1	22.1
9-10-11 rib section		
% fat	26.42	30.26
% lean	53.39	51.26
% bone	19.26	17.76
Marbling score[2]	10.8	10.1
Color fat[3]	2	2
Color lean[4]	2.8	3.3

[1] 1-inch cores
[2] 10 = traces, 11 = practically devoid
[3] 2 = yellowish tinge
[4] Munsell color paddles--the smaller the number the lighter the color.

PERFORMANCE OF COW HERDS. 1959 CALVES

Kentucky Station

Location	Mercer Farm	Mercer Farm
Breed of sire	Hereford	Hereford
Breed of dam	Hereford	Red Poll
No. cows calving	12	16
No. calves raised	12	15
Av. birth date	1/21/59	1/21/59
Av. birth wt. (lbs.)	71	82
Av. weaning age (days)	260	260
Av. weaning wt.	495	609
Av. weaning type score	10.3	9.1
Av. weaning condition score	9.2	10.5
Were calves creep fed?	1/2 were 1/2 were not	1/2 were 1/2 were not
Adjusted[1] av. daily gain from birth to weaning	1.72	1.97

[1] Adjusted for sex of calf, age of dam, season of birth.

DATA ON ANIMALS SLAUGHTERED

	Kentucky Station	
Location	Mercer	Mercer
Breed of sire	Hereford	Hereford
Breed of dam	Hereford	Red Poll
Sex	5 heifers 7 steers	4 heifers 11 steers
No. slaughtered	12	15
Age at slaughter (days)	260	260
Final farm weight	495	609
Slaughter weight[(1)]	477	587
Carcass weight[(2)]	266	345
Dressing percentage[(3)]	55.7	58.8
Slaughter grade	9.2	10.5
Carcass grade	7.8	8.7
Fat thickness over rib eye (ins.)	.33	.39
Rib eye area (sq. in.)	6.18	7.59
W-B Shear	1-inch	1-inch
Shear Force (lbs.)	21.11	22.11
9-10-11 Rib Section		
%Fat	26.42	30.26
%Lean	53.39	51.26
%Bone	19.26	17.76
Other observations on carcass:		
Marbling score[(4)]	10.8	10.1
Color fat[(5)]	2	2
Color lean[(6)]	2.8	3.3

(1) Twenty hours elapsed. The calves were held over night at the packing plant with access to water only.
(2) 48-hour chilled carcass weight.
(3) Slaughter weight and 48-hour chilled carcass weights were used to calculate dressing percentage.
(4) 10 = traces, 11 = practically devoid
(5) 2 = yellowish tinge.
(6) Munsell color paddles - the smaller the number the lighter the color.

LA (1)

Louisiana Station

by

R. S. Temple

I. PROJECT: Anim. Indus. 605 (S-10)

Comparison of Various Crossbred Cattle Under Gulf Coast Conditions with Respect to Rate of Growth on Pasture, Fattening Ability, and Meat Quality of Steers

II. OBJECTIVES:

A. To study types and breeds of beef cattle to determine which are best suited to conditions along the Gulf Coast, with respect to rate of growth, fattening ability and meat quality.

B. To study various crossbreeding programs as to practicality, production and usefulness.

C. To study the amount of hybrid vigor obtained through crossing beef breeds and to ascertain how much of this hybrid vigor is maintained through subsequent backcrossing, multiple breed crossing and rotational crossing.

D. To study the productive ability of dams of various breeds and crosses.

E. To estimate genetic parameters.

F. To study practical problems of management and marketing of crossbred cattle in the Gulf Coast area.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and Animals

A small feed lot for full feeding weanling calves was built. It will handle 35 to 40 head quite nicely.

An additional fifty acre pasture has been cleared and is being leveled, drained and fenced for use in the near future. Use of approximately 160 acres has been granted the project until further specific projects and departments are assigned the area.

The 1957 heifers were used in the herds as replacements where ever needed. None of these heifers were sold.

B. Research Results:

The crossbreeding experiment at Louisiana State University is now in its ninth year. The single cross cows are now being bred back to their breed of sire. The third calf crop of this backcross phase is now on the ground and the second group of steers is now in the feed lot. Only a limited amount of information is available from the backcrosses for analysis but some observations are worth considering at this time. No statistical analyses have been made on these data.

The backcross phase of the project, which followed the producing of single crosses, started with the 1957 breeding season producing the first calves in the Spring of 1958. The cattle used in this phase were the cattle produced in the first or single cross phase. Thus, the backcross consisted of mating the single cross cows back to a sire of the same breed as her sire. The offspring of this type of mating were compared to straightbred cattle of the various breeds. The same six breeds of sire used in the first phase are being used in the second phase. These include Angus, Brahman, Brangus, Charolaise, Hereford and Shorthorn. Each breed of sire is being mated to its respective straightbred females and all the crosses involving that breed with the exception of the Charolaise and Shorthorns. For example, the Angus sires are mated to females of the following breeding: straight Angus, Angus x Brahman, Angus x Brangus and Angus x Hereford. Since there are no straight bred Charolaise or Shorthorn cows in the first phase, the Charolaise and Shorthorn sires are mated to their respective crosses. For example, the Charolaise sires are mated to Charolaise x Angus, Charolaise x Brahman, Charolaise x Brangus and Charolaise x Hereford cows.

The third calf crop of this phase is now on the ground. The second group of steers of this phase has just recently been taken off test and slaughtered, but the carcass data on this group are yet incomplete.

The calves from Brangus sires, that is, calves that are at least 3/4 Brangus had the highest average rate of gain from birth to weaning when 1958 and 1959 calves of a particular breed of sire were averaged. The calves from Brangus sires also averaged highest for adjusted 180-day weight and feeder calf grade for the two years. The 180-day weight was adjusted for age of calf, sex of calf and age of dam. The calves from Hereford sires (average of straight bred and 3/4 Hereford) averaged the highest for slaughter grade. However, considerable yearly environmental information exists in the data. The rankings of the means by sire group for daily gain, feeder calf grade, slaughter calf grade and adjusted 180-day weight for 1958, 1959 and the average of the two years are as follows:

	Daily Gain			Feeder Calf Grade			Slaughter Calf Grade			Adjusted 180-day Weight		
	1958	1959	Ave.	1958	1959	Ave.	1958	1959	Ave.	1958	1959	Ave.
A	6	2	5	6	1	6	6	1	4	5	5	5
B	3	3	3	3	3	3	2	5	5	4	2	3
BA	2	1	1	2	5	1	1	4	3	2	1	1
Ch	1	5	2	1	6	4	4	6	6	1	3	2
H	4	4	4	4	2	3	3	2	1	3	4	4
Sh	5	6	6	5	4	5	5	3	2	6	6	6

The calf crop percentage (.70) was considerably better in 1959 than in 1958 (.58). This change is not due to any particular change in the mating system. It has to be accounted for to some extent by yearly variation, however, one group (Brangus) was mated artificially. They were among the lowest in conception rate in 1958. This area of reproduction needs considerable work and study in the Gulf Coast area. Improvement in calving percentages is imperative for further and continued success in the beef cattle business.

The 1958 steers fed out in the feed lot averaged about 2.0 pounds a day for 168 days. The calves sired by Brahman bulls (3/4 or full bred Brahman calves) gained the least (1.51 lb./day) while the 3/4 Charolaise calves gained the best (2.35 lb./day). The calves sired by Angus, Hereford, Shorthorn and Brangus bulls gained 2.1, 2.0, 1.9, and 1.9 pounds per day, respectively.

The 1959 steers that were fed out this past winter did not gain as well (1.6 lb./day) on the whole as the 1958 steers. The winter pasture was slow this past winter and the cold weather lasted about 3 weeks longer than it did in 1959. These data will be reported next year.

Forty matings were made in 1959 involving animals that showed varying degrees of double muscling. Two bulls, an Africander and an Angus, were used in the matings. Both bulls showed extreme evidence of the trait and both bulls had history of double muscling in their ancestors. Twenty-three of the cows had calves that lived; three calves died at birth. All three of these calves showed extreme evidence of the trait and were out of cows that were sired by the Africander double muscled bull. However, these three cows showed no evidence of double muscling themselves.

The Angus sire was mated to five cows that did not show the trait but were sired by a double muscled bull, and all five calves resulting did show the trait. He was mated to two cows that showed double muscling. One calf showed the trait and the

other appears normal. These matings indicate that the trait is not inherited as a recessive but might be explained as a dominant if the sire is a heterozygote. The Africander sire was mated to thirteen cows that did not show the trait nor had any history of double muscling. Six calves showed double muscling and seven did not. He was mated to three of his daughters that showed the trait that were out of cows that had the trait. Two of the calves showed the trait and one did not. These matings also indicate that dominance may explain the inheritance. There seems to be no difference between male and female calves in the frequency or the expressivity of double muscling. It has appeared that some calves tend to show the trait more as they become older. Three of the calves in this year's matings failed to show the characteristic at birth but the trait was quite pronounced a month after birth.

IV. FUTURE PLANS:

A revision of the crossbreeding experiment is underway so as to obtain information on straightbreds, single crosses, backcrosses, three-breed crosses and rotational crosses simultaneously. Due to the large year differences noted in beef production traits, it is desirable to analyze the different systems of crossing in the same year. More complete genetic answers as to the amount of hybrid vigor which can be expected by crossing should be forthcoming. Also, to be studied is how much of the gain introduced by heterosis is maintained through subsequent crosses. This experiment will also serve as a practical demonstration to breeders as to how to carry on and maintain a practical crossbreeding operation.

The revision of the crossbreeding experiment will go into effect this breeding season and will replace the third phase (three-breed phase) of the original project. Since the revision makes provisions for additional backcross calves it is feasible to terminate the second phase (backcross) at this time. The duration of the planned revision will be for eight years. The same information that has been gathered heretofore will be gathered in the future.

The same six breeds of sire will be used, i.e., Angus, Brahman, Brangus, Charolaise, Hereford and Shorthorn. Two sires of each breed will be used each year to give estimates of genetic parameters, i.e., heritabilities and genetic correlations. The sires will be mated to identical herds of cows, in so far as breed of cow is concerned, with the exception of the Charolaise and Shorthorn. Each herd will contain straightbred Angus, Brahman, Brangus and Hereford cows and the crosses among these four breeds. In addition to these cows, the herds mated to the Charolaise and Shorthorn bulls will include Charolaise x Angus, Charolaise x Brahman, Charolaise x Brangus, Charolaise x Hereford and Shorthorn x Angus, Shorthorn x Brahman, Shorthorn x Brangus and Shothorn x Hereford cows, respectively. As backcross and three-breed females are produced they will be mated to the correct sire for rotational crosses.

An experiment is being initiated to study the growth curve of calves under three pre-weaning (weaning at eight months) feeding programs. The three programs are: (1) wean at an average age of 248 days with no creep feed; (2) wean at an average age of 248 days with free choice of a creep ration (7parts corn, 2 parts oats, 1 part cottonseed meal, 1 part soybean oil meal, 1 part bran) from 4 months of age to weaning; (3) wean at an average age of 150 days and put on good pasture with free choice of the above ration. The latter two programs were designed in an effort to increase the growth rate from five months to eight months of age. This experiment will be carried on for three years. Growth rate, carcass and slaughter grades, carcass breakdown and cost of information will be gathered. The calves used will be of varying ages, both sexes, different age dams and different breeds and crosses. Due to the limited numbers of the different breeds and crosses, and age of dams and calves, the different weaning programs will be randomized over the above factors. Differences in sexes will be analyzed.

An experiment is being initiated to study three different feeding and slaughter programs for the Gulf Coast area. This experiment will be carried on for three years. Sixty-three calves, not involved in the crossbreeding experiment, were divided into three groups at random according to sex, breed, and previous treatment. The first group of calves was slaughtered at weaning (approximately 8 months of age). The second group was started on feed in dry lot after a two-week period of bringing up to full feed. These calves will be fed all they can eat until they reach a grade of "high good" or "low choice" at which time they will be slaughtered. The third group is being held over on a growing ration until they average about 18 months of age. These cattle will then be put on full feed and fed until they reach "high good" or "low choice."

These three groups will be compared as to cost of production, growth rate, slaughter grade and carcass information.

Artificial insemination has been well accepted and is widely used in dairy herds and some purebred beef operations. It is being tried in some commercial herds but mainly on a try-out basis. Many problems arise in artificial insemination when it is used on a large scale operation - observation of a cow in heat, handling the cows to maintain their heat, and successful insemination are just a few of these problems. An additional problem in our region is the use of Brahman and Brahman crossbred females. The estrus is more difficult to observe in these cows and they are harder to handle than the European breeds. An experiment using straight-bred European and Brahman cows along with several kinds of crossbred cows will be carried out at L.S.U. This experiment will be on a practical ranch basis where the ranch hands will observe the cows and bring them to the inseminator.

A study of age of puberty in straight-bred heifers initiated at L.S.U. this past year has prompted a continuation of the study in not only the

straightbreds but also in crossbred heifers. Vasectomized bulls marked with dye are being used to detect the presence of estrus in these heifers. It has been established that Brahman heifers do not reach puberty as early as do the European breeds but little work has been done concerning puberty in crosses between Brahmans and the European breeds.

The increasing interest and demand for Charolaise cattle has made necessary the evaluation of this breed. This will be accomplished by developing a herd of approximately pure Charolaise cattle through grading-up by use of pure Charolaise bulls. The cattle will be evaluated as to their productive ability and carcass traits under the sub-tropical conditions. In addition to their evaluation as a breed, these cattle will be utilized in a cow-calf management program. Fall calving versus spring calving will be studied along with aspects of marketing.

V. PUBLICATIONS DURING THE YEAR:

Damon, R. A., Jr., S. E. McCraine, R. M. Crown and C. B. Singletary. Gains and grades of beef steers in the Gulf Coast region. J. An. Sci: Vol. 18, No. 3, August, 1959.

Crown, R. M. and R. A. Damon, Jr. The value of the 12th rib cut for measuring beef carcass yields and meat quality. J. An. Sci: Vol. 19, No. 1, February, 1960.

Fowler, S. H., A. M. Mullins, and George L. Robertson. Crossbreeding beef cattle. La. Agr., Vol. 3, No. 2

Damon, R. A., Jr. and others. Carcass characteristics of purebred and crossbred beef steers in the Gulf Coast region. J. An. Science (In press).

VI. PUBLICATIONS PLANNED:

Sullivan, John S. Estimates of some factors which affect weaning weight of calves in the Gulf Coast area. MS Thesis, Louisiana State University.

Temple, Robert S., A review of crossbreeding at L.S.U. La. Agri. Expt. Sta. Bulletin.

PERFORMANCE OF COW HERDS. 1959 CALVES

Louisiana Station

Location	Baton Rouge, Louisiana					
Breed of sire / Breed of dam	Angus A-BA	Angus A-H	Angus A-B	Brahman B-BA	Brahman B-A	Brahman B-H
No. cows calving	4	4	5**	7	8	7
No. calves raised	4	4	5	7	7	7
Av. birth date	1-27-59	2-1-59	2-23-59	3-5-59	2-15-59	2-16-59
Av. birth wt. (lbs.)	66.0	66.8	61.0	75.7	73.1	79.4
Av. weaning age	235.8	255.5	234.6	224.4	240.6	240.9
Av. weaning wt.	427.5	432.5	520.0	445.7	469.3	500.7
Av. weaning type score	L-Choice	L-Choice	Choice	L-Choice	L-Choice	Choice
Av. weaning condition score	H-Good	Good	H-Good	L-Good	L-Good	Good
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning (180 days)*	2.19	2.04	2.51	2.29	2.36	2.47

*Adjusted for age of dam and sex of calf

**Twin calves in this group

Breed of sire / Breed of dam	Brahman Brahman	Brangus Brangus	Brangus BA-A	Brangus BA-H	Brangus BA-B	Charolaise C-BA
No. cows calving	4	5	2	5	6	8
No. calves raised	3	5	2	4	4	8
Av. birth date	2-22-59	1-31-59	4-20-59	3-5-59	2-3-59	2-13-59
Av. birth wt. (lbs.)	62.5	81.6	78.0	79.4	63.0	78.8
Av. weaning age	228.7	256.6	177.5	222.0	251.2	244.5
Av. weaning wt.	401.7	525.0	397.5	467.5	516.2	491.9
Av. weaning type score	L-Choice	H-Good	L-Choice	L-Choice	L-Choice	L-Choice
Av. weaning condition score	Good	L-Good	L-Good	Good	H-Good	H-Good
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning (180 days)*	2.19	2.44	2.37	2.54	2.41	2.41

PERFORMANCE OF COW HERDS. 1959 CALVES

Louisiana Station

Location	Baton Rouge, Louisiana					
Breed of sire Breed of dam	Charolaise C-A	Charolaise C-H	Charolaise C-B	Hereford H.BA	Hereford H-A	Hereford Hereford
No. cows calving	7**	6	6	8	3	6
No. calves raised	8	6	5	8	3	6
Av. birth date	2-14-59	1-26-59	2-14-59	2-23-59	3-26-59	2-23-59
Av. birth wt.(lbs.)	74.2	79.2	68.2	67.4	75.7	61.5
Av. weaning age	243.1	261.8	240.4	233.5	193.3	233.5
Av. weaning wt.	410.6	485.0	494.0	443.1	366.7	362.5
Av. weaning type score	L-Good	L-Choice	L-Choice	L-Choice	L-Choice	H-Good
Av. weaning condition score	L-Good	Good	Good	H-Good	Good	Good
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning*	2.11	2.40	2.51	2.24	2.13	2.04
Breed of sire Breed of dam	Hereford H-B	Shorthorn S-BA	Shorthorn S-A	Shorthorn S-H	Shorthorn S-B	Angus A crosses
No. cows calving	7	6	8	8	7	13**
No. calves raised	7	5	7	7	7	13
Av. birth date	1-31-59	2-9-59	2-3-59	2-8-59	2-8-59	2-13-59
Av. birth wt.(lbs.)	67.3	63.8	67.2	74.9	65.7	69.0
Av. weaning age	256.6	260.4	254.4	247.6	249.3	241.4
Av. weaning wt.	553.6	425.0	384.0	417.9	474.3	464.6
Av. weaning type score	Choice	Choice	H-Good	L-Choice	Choice	Choice
Av. weaning condition score	L-Choice	H-Good	L-Good	Good	H-Good	H-Good
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning*	2.61	2.11	2.05	2.18	2.41	2.27

*Adjusted for age of dam and sex of calf
**Twin calves in this group
Code for Breeds: A-Angus, B-Brahman, BA-Brangus, C-Charolaise, H-Hereford and S-Shorthorn.

PERFORMANCE OF COW HERDS. 1959 CALVES

Louisiana Station

Location Breed of sire Breed of dam	Baton Rouge, Louisiana Brahman B crosses	 Brangus BA crosses	 Charolaise C crosses	 Hereford H crosses	 Shorthorn S crosses
No. cows calving	26	18	27**	24	29
No. calves raised	24	15	27	24	26
Av. birth date	2-21-59	2-19-59	2-10-59	2-20-59	2-7-59
Av. birth wt. (lbs.)	73.9	74.4	78.1	66.9	68.3
Av. weaning age	234.4	235.4	247.2	235.2	252.3
Av. weaning wt.	463.1	490.3	466.7	445.6	425.4
Av. weaning type score	L-Choice	L-Choice	L-Choice	L-Choice	L-Choice
Av. weaning condition score	L-Good	Good	L-Good	H-Good	Good
Were calves creep fed?	No	No	No	No	No
Adjusted av. daily gain from birth to weaning*	2.35	2.45	2.34	2.28	2.19

*Adjusted for age of dam and sex of calf.
Code for Breeds: A-Angus, B-Brahman, BA-Brangus, C-Charolaise, H-Hereford and S-Shorthorn.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Louisiana Station

Location Breed of sire Breed of dam	---Baton Rouge, Louisiana--- Angus A-BA	Angus Angus	Angus A-H	Angus A-B	Brahman B-Ba	Brahman B-A	Brahman B-H
STEERS, No.	2	3	1		4	2	2
Av. initial age (days)	283.5	267.7	279.0		269.0	261.0	230.5
Av. initial wt. (lbs.)	410.0	381.7	400.0		461.2	462.5	472.5
Av. no. days on feed	168	168	168		168	168	168
Av. final weight	735.5	753.3	750.0		680.0	707.5	750.0
Av. daily gain	1.95	2.21	2.08		1.30	1.46	1.66
Av. score							
Conformation	H-Good	L-Choice	H-Good		H-Good	H-Good	H-Good
Condition	Good	H-Standard	Good		Good	H-Good	H-Good
HEIFERS, No.	1	1	4	3	3	2	3
Av. initial age (days)	182.0	248.0	265.8	269.3	216.7	255.0	247.0
Av. initial wt. (lbs.)	325.0	325.0	397.5	466.7	406.7	485.0	461.7
Av. no. days on feed	154	154	154	154	154	154	154
Av. final weight	550.0	440.0	590.0	600.0	515.0	645.0	575.0
Av. daily gain	1.46	.75	1.25	.87	.70	1.04	.74

Steers were group fed an eight pound ration (corn - 5, CS meal - 1, oats - 2, Soybean oil meal - 1, bran - 1) per head per day plus four pounds grass hay per steer per day plus pasture. Heifers were fed a four pound concentrate ration per head per day plus six pounds of grass hay and pasture.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Louisiana Station

Location	Baton Rouge, Louisiana						
Breed of sire	Brahman	Brangus	Brangus	Brangus	Brangus	Charolaise	Charolaise
Breed of dam	Brahman	Brangus	BA-A	BA-H	BA-B	C-BA	C-A
STEERS, No.	3	1	1	2		1	3
Av. initial age (days)	228.7	274.0	216.0	210.5		184.0	225.0
Av. initial wt. (lbs.)	408.3	500.0	425.0	427.5		395.0	458.3
Av. no. days on feed	168	168	168	168		168	168
Av. final weight	696.7	805.0	755.0	735.0		820.0	883.3
Av. daily gain	1.72	1.82	1.96	1.84		2.53	2.53
Av. score							
Conformation	H-Good	L-Choice	H-Good	L-Choice		L-Choice	L-Choice
Condition	Good	H-Good	Good	H-Good		H-Good	Good
HEIFERS, No.	1		1	3			1
Av. initial age (days)	232.0		202.0	219.0			220.0
Av. initial wt. (lbs.)	290.0		410.0	466.7			465.0
Av. no. days on feed	154		154	154			154
Av. final weight	425.0		535.0	601.7			620.0
Av. daily gain	0.88		0.81	0.88			1.01

Steers were group fed an eight pound ration (corn - 5, CS meal - 1, oats - 2, Soybean oil meal - 1, bran - 1) per head per day plus four pounds grass hay per steer per day plus pasture. Heifers were fed a four pound concentrate ration per head per day plus six pounds of grass hay and pasture.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Louisiana Station

Location Breed of sire Breed of dam	Baton Rouge, Louisiana Charolaise C-H	 Charolaise C-B	 Hereford H-BA	 Hereford H-A	 Hereford Hereford	 Hereford H-B	 Shorthorn S-BA
STEERS, No.	1	2	3	4	3	4	2
Av. initial age (days)	241.0	208.5	248.3	267.6	263.3	264.8	284.5
Av. initial wt. (lbs.)	425.0	500.0	438.3	401.2	400.0	543.8	450.0
Av. no. days on feed	168	168	168	168	168	168	168
Av. final weight	760.0	865.0	761.7	772.5	741.7	856.2	825.0
Av. daily gain	1.99	2.17	1.93	2.21	2.03	1.86	2.23
Av. score							
Conformation	H-Good	L-Choice	H-Good	H-Good	H-Good	L-Choice	H-Good
Condition	Good	L-Good	Good	Good	L-Good	L-Choice	Good
HEIFERS, No.		2	3	1	1	2	3
Av. initial age (days)		193.0	257.3	267.0	241.0	240.5	255.3
Av. initial wt. (lbs.)		547.5	481.7	430.0	400.0	430.0	446.7
Av. no. days on feed		154	154	154	154	154	154
Av. final weight		710.0	606.7	620.0	540.0	557.5	623.3
Av. daily gain		1.06	0.81	1.23	0.91	0.83	1.15

Steers were group fed an eight pound ration (corn - 5, CS meal - 1, oats - 2, Soybean oil meal - 1, bran - 1) per head per day plus four pounds grass hay per steer per day plus pasture. Heifers were fed a four pound concentrate ration per head per day plus six pounds of grass hay and pasture.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Location	Baton Rouge, Louisiana				
Breed of sire / Breed of dam	Shorthorn S-A	Shorthorn S-H	Shorthorn S-B	Angus A crosses	Brahman B crosses
STEERS, No.	2	2	2	6	11
Av. initial age (days)	289.0	278.0	280.5	274.8	249.5
Av. initial wt. (lbs.)	395.0	365.0	475.0	394.2	449.1
Av. no. days on feed	168	168	168	168	168
Av. final weight	715.0	652.5	785.0	747.5	702.3
Av. daily gain	1.90	1.72	1.85	2.10	1.51
Av. score					
Conformation	Good	H-Good	L-Choice	Good	H-Good
Condition	L-Good	L-Good	H-Good	L-Good	Good
HEIFERS, No.	2	4	5	9	9
Av. initial age (days)	275.0	270.0	255.8	255.7	237.0
Av. initial wt. (lbs.)	325.0	365.0	462.0	404.4	429.4
Av. no. days on feed	154	154	154	154	154
Av. final weight	490.0	496.3	600.0	572.2	553.9
Av. daily gain	1.07	0.85	0.90	1.09	0.81

Steers were group fed an eight pound ration (corn - 5, CS meal - 1, oats 2, Soybean oil meal - 1, bran - 1) per head per day plus four pounds grass hay per steer per day plus pasture. Heifers were fed a four pound concentrate ration per head per day plus six pounds of grass hay and pasture.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Louisiana Station

Location	Baton Rouge, Louisiana			
Breed of sire	Brangus	Charolaise	Hereford	Shorthorn
Breed of dam	BA crosses	C crosses	H crosses	S crosses
STEERS, No.	4	7	14	8
Av. initial age (days)	227.8	216.7	260.4	283.0
Av. initial wt. (lbs.)	445.0	456.4	449.6	421.2
Av. no. days on feed	168	168	168	168
Av. final weight	757.5	851.4	787.5	744.4
Av. daily gain	1.86	2.35	2.01	1.92
Av. score				
Conformation	L-Choice	L-Choice	H-Good	H-Good
Condition	H-Good	Good	Good	Good
HEIFERS, No.	4	3	7	14
Av. initial age (days)	214.8	202.0	251.6	262.5
Av. initial wt. (lbs.)	452.5	520.0	447.9	411.5
Av. no. days on feed	154	154	154	154
Av. final weight	585.0	680.0	585.0	559.6
Av. daily gain	0.86	1.04	0.89	0.96

Steers were group fed an eight pound ration (corn - 5, CS meal - 1, oats - 2, Soybean oil meal - 1, bran - 1) per head per day plus four pounds grass hay per steer per day plus pasture. Heifers were fed a four pound concentrate ration per head per day plus six pounds of grass hay and pasture.

DATA ON ANIMALS SLAUGHTERED

Louisiana Station

Location	Baton Rouge, Louisiana						
Breed of sire	Angus	Angus	Angus	Brahman	Brahman	Brahman	Brahman
Breed of dam	A-BA	Angus	A-H	B-BA	B-A	B-H	Brahman
Sex	Male	Male	Male	Male	Male	Male	Male
No. slaughtered	2	3	1	4	2	2	3
Age at slaughter	451.5	435.7	447.0	437.0	429.0	398.5	396.7
Time in feedlot (days)	168	168	168	168	168	168	168
Gain in feedlot (lbs.)	327.5	371.7	350.0	218.8	245.0	277.5	288.3
Final feedlot weight	737.5	753.3	750.0	680.0	707.5	750.0	696.7
Carcass weight(1)	428.5	431.3	422.0	388.8	397.0	417.0	396.7
Dressing percentage(2)	58.04	57.18	56.27	56.66	56.12	55.52	56.95
Slaughter grade	L-Choice	H-Good	L-Choice	Good	Good	Good	Good
Carcass grade	Good	H-Good	H-Good	H-Standard	H-Standard	H-Standard	Standard
Fat thickness over rib eye (ins.)	0.48	0.52	0.79	0.45	0.51	0.42	0.25
Rib eye area (sq. in.)	8.26	10.04	8.97	8.28	8.08	7.45	8.42
W-B Shear							
Core size	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch
Shear force (lbs.)	14.02	13.30	11.75	18.34	17.38	16.62	17.14
9-10-11 Rib Section							
Weight in lbs.	6.8	7.5	7.2	5.8	5.9	5.7	5.6
% Fat	33.27	27.78	31.84	19.18	22.51	20.28	15.23
% Lean	49.15	55.58	52.20	57.88	67.53	58.28	64.37
% Bone	17.27	16.63	15.95	20.44	22.71	21.44	20.40

(1) Cold carcass weight.
(2) Final feedlot weight and cold carcass weight.

DATA ON ANIMALS SLAUGHTERED

Louisiana Station

Location	Baton Rouge, Louisiana						
Breed of sire Breed of dam	Brangus Brangus	Brangus BA-A	Brangus BA-H	Charolaise C-BA	Charolaise C-A	Charolaise C-H	Charolaise C-B
Sex	Male	Male	Male	Male	Male	Male	Male
No. slaughtered	1	1	2	1	3	1	2
Age at slaughter	442.0	384.0	378.5	352.0	393.0	409.0	376.5
Time in feedlot (days)	168	168	168	168	168	168	168
Gain in feedlot (lbs.)	305.0	330.0	307.5	425.0	425.0	335.0	365.0
Final feedlot weight	805.0	755.0	735.0	820.0	883.3	760.0	865.0
Carcass weight(1)	463.0	441.0	425.5	463.0	502.3	440.0	471.5
Dressing percentage(2)	57.52	58.41	57.88	56.46	56.82	57.89	54.45
Slaughter grade	L-Good	Good	H-Good	H-Good	H-Good	Good	L-Good
Carcass grade	Standard	Good	Good	L-Good	Good	L-Standard	L-Standard
Fat thickness over rib eye (ins.)	0.29	0.31	0.46	0.43	0.43	0.16	0.38
Rib eye area (sq. in.)	11.20	10.55	8.70	10.47	10.33	11.45	10.00
W-B Shear							
Core size	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch
9-10-11 Rib Section	18.29	15.67	11.98	10.29	17.85	19.50	15.94
Weight in lbs.	7.7	7.0	6.6	7.5	8.0	7.2	6.8
% Fat	29.21	32.41	29.56	26.85	24.03	13.51	13.22
% Lean	53.55	53.96	52.93	56.44	57.84	68.96	67.14
% Bone	17.24	13.63	17.52	16.72	18.13	17.53	19.64

(1) Cold carcass weight
(2) Final feedlot weight and cold carcass weight.

DATA ON ANIMALS SLAUGHTERED

Louisiana Station

Location	Baton Rouge, Louisiana						
Breed of sire	Hereford	Hereford	Hereford	Hereford	Shorthorn	Shorthorn	Shorthorn
Breed of dam	H-BA	H-A	Hereford	H-B	S-BA	S-A	S-H
Sex	Male	Male	Male	Male	Male	Male	Male
No. slaughtered	3	4	3	4	2	2	2
Age at slaughter	416.3	430.8	431.3	432.8	452.5	457.0	446.0
Time in feedlot (days)	168	168	168	168	168	168	168
Gain in feedlot (lbs.)	323.3	371.2	341.7	312.5	375.0	320.0	287.5
Final feedlot weight	761.7	772.5	741.7	856.2	825.0	715.0	652.5
Carcass weight(1)	426.7	439.5	405.0	501.2	481.5	407.0	356.5
Dressing percentage(2)	55.87	56.88	54.45	58.54	58.38	56.92	54.65
Slaughter grade	Good	Good	L-Good	L-Choice	L-Choice	Good	Good
Carcass grade	L-Good	L-Good	H-Standard	L-Good	Good	Good	Good
Fat thickness over rib eye (ins.)	0.38	0.50	0.30	0.39	0.64	0.52	0.40
Rib eye area (sq. in.)	8.49	8.48	8.23	8.87	8.20	7.60	8.17
W-B Shear							
Core size	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch
Shear Force (lbs.)	14.36	10.74	14.93	15.33	20.40	13.44	20.60
9-10-11 Rib Section							
Weight in lbs.	6.8	7.0	6.5	7.6	8.0	6.0	5.5
% Fat	26.59	26.82	28.72	24.52	37.44	32.92	28.60
% Lean	54.04	56.96	53.47	58.04	48.57	50.44	53.71
% Bone	19.37	16.22	17.81	17.44	13.99	16.63	17.68

(1) Cold carcass weight.
(2) Final feed lot weight and cold carcass weight.

DATA ON ANIMALS SLAUGHTERED

Louisiana Station

Location	---Baton Rouge, Louisiana---						
Breed of sire Breed of dam	Shorthorn S-B	Angus A crosses	Brahman B crosses	Brangus BA crosses	Charolaise C crosses	Hereford H crosses	Shorthorn S crosses
Sex	Male	Male	Male	Male	Male	Male	Male
No. slaughtered	2	6	11	4	7	14	8
Age at slaughter	448.5	442.8	417.5	395.8	384.7	428.4	451.0
Time in feedlot (days)	168	168	168	168	168	168	168
Gain in feedlot (lbs.)	310.0	353.3	253.2	312.5	395.0	337.9	323.1
Final feedlot weight	785.0	747.5	702.3	757.5	851.4	787.5	744.4
Carcass weight(1)	451.5	428.8	397.5	438.8	479.0	447.0	424.1
Dressing percentage(2)	57.58	57.32	56.43	57.93	56.24	56.61	56.88
Slaughter grade	Good	H-Good	Good	Good	Good	L-Choice	H-Good
Carcass grade	H-Standard	Good	Standard	L-Good	H-Standard	L-Good	Good
Fat thickness over rib eye (ins.)	0.38	0.55	0.40	0.38	0.32	0.40	0.48
Rib eye area (sq. in.)	8.25	9.28	8.13	9.79	10.42	8.54	8.05
W-B Shear							
Core size	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch	1 inch
Shear force (lbs.)	20.38	13.28	17.52	14.48	16.46	13.73	18.70
9-10-11 Rib Section							
Weight in lbs.	6.8	7.2	5.7	7.0	7.5	7.0	6.6
% Fat	26.68	30.29	19.82	30.18	19.84	26.52	31.41
% Lean	57.22	52.87	61.48	53.34	61.89	55.89	52.49
% Bone	16.09	16.73	21.02	16.48	18.27	17.58	16.10

(1) Cold carcass weight.
(2) Final feedlot weight and cold carcass weight.

JEAN. LA (1)

Jeanerette, Louisiana Station

by

T. M. DeRouen

I. PROJECT: AHRD d1-6 (S-10)(Revised)

Development of Pure and Crossbred Types of Cattle for Southeastern United States and the Gulf Coast Region

II. OBJECTIVE:

To evaluate strains of Brahman-Angus and Africander-Angus in comparison with straight Brahman, Angus and 1st crosses of these breeds with respect to the utilization of grasses, roughages and other feeds in the production of beef.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. There are six closed lines of Brahman-Angus, four closed lines of Africander-Angus, an Angus herd and a Brahman herd. All were used in obtaining and comparing the data.

A total of 267 cows were bred in the spring of 1958. Fourteen herds were made up for pasture breeding consisting of 120 Brahman-Angus cows, 60 Africander-Angus cows, 39 Brahman cows, 35 Angus cows and 13 Sindhi cows.

The Sindhi cows were randomly assigned to two Angus bulls during the 1958 breeding season. The Sindhi females are being used to explore the possibility of these cows for beef production along the Gulf Coast.

This year reciprocal first crosses were made between the Angus and Brahman for comparison with the crossbred lines. Considerable heterosis was demonstrated particularly in the Brahman-Angus F_1 calves by their heavier weaning weights.

The Brahman-Angus lines continue to show their superiority over the Africander-Angus, Angus and Brahman by their heavier weights at weaning. The Africander-Angus cows appear to be slightly more fertile than the Brahman-Angus and the calves are stronger at birth than the latter.

The small number of calves from the Brahman cows was due to one Brahman bull that settled only 33 percent of the cows in his breeding herd. In addition, the winter of 1958-59 was particularly severe during the calving season, being cold and wet, and this seemed to be fatal to many of the purebred Brahman calves.

All cows exposed to bulls during the spring breeding season, were rectally palpated in early fall to determine pregnancy and thereby to improve reproductive efficiency. The breeding season began on April 1 and ended on June 15, lasting 75 days.

The accompanying table "Performance of Cow Herds" shows some of the results obtained.

B. Selection of bull calves to be placed on feed for performance testing was made in the fall at weaning. A total of thirty calves were selected. Twenty of the bull calves were fed in individual pens while ten were fed in one group because of a shortage of pens.

The calves were started on official feed on October 14, 1958, and continued on a full feed for 154 days. In this year's test the Africander-Angus bulls had a slightly higher, but insignificant, daily gain over the Brahman-Angus bull calves. The purebred Angus bull calves did surprisingly well in this year's gain test. They had the highest type and condition scores at the end of the feed test.

Some of the data on the bull calves is given in the schedule on postweaning performance of 1958 calves full fed after weaning.

C. Performance and carcass data were studied on the steers born in 1958. After weaning in the fall, the calves were castrated and placed on pasture. While on pasture, they received approximately four pounds of concentrates (equal parts of corn and cottonseed meal) daily until April 14, 1959, when they went on official performance test.

In the beginning of the feeding test, it was decided to limit the concentrates since the steers were on good pasture. However, after the second 28-day weighing, it was noted that in spite of the good pasture, the steers were not gaining as well as should be, so they were pushed to a full feed of concentrates on pasture.

At the time the steers were supposed to be slaughtered, a labor strike occurred at the packing plant at which the steers were to be slaughtered. There was no alternative and the animals were held on feed approximately one month longer than anticipated.

It is to be noted that the Brahman-Angus steers outgained all the other steers except the one Sindhi-Brahman steer. However, the Angus steers rated highest in the slaughter grade.

D. Some of the slaughter and carcass data on the steers is presented in the table on "Data on Animals Slaughtered." Although numbers are small, the purebred Angus steers ranked first in slaughter and carcass grade. The crossbred strains of steers had a significantly larger rib eye area than the purebred steers. This may be due to their larger size. The shear force value of the rib eye cores of the Angus steers indicated that they were more tender than that of the other steers. The shear force in this year's work showed that the Brahman-Angus steers had the least tender meat.

E. The attainment of puberty (time of first heat) among heifers born in 1958 has been checked systematically since the first of April, 1959. The ovaries of these heifers were palpated for the presence of corpora lutea and none were found previous to this date. The checking for estrus was done by using vasectomized bulls. The briskets of these bulls were painted with colored multi-purpose grease for marking the rumps of the heifers they served.

There were six purebred Brahman heifers and one purebred Angus heifer among these females. None of the purebreds came into heat during the period of checking.

Pertinent information is presented in a table to follow.

F. Collection of blood from 629 beef cattle was done on April 21 and 22, 1959, to determine the status of Anaplasmosis in the beef herd. When the sera of the blood was subjected to the complement-fixation tests for Anaplasmosis, it was found that there was 28.4%, which were either reactors or suspects to Anaplasmosis.

Comparing this test with the one made in December, 1958, it is observed that the overall incidence of reactors and suspects declined from 41.7% to 28.4%.

During 1959, three cows showing symptoms of Anaplasmosis were treated and all recovered. The above cases were observed on September 8, 1959 when several herds were being moved from one pasture to another. When the blood of these cows was sent to be tested, the reply from the test was that the cows were in the recovery stage of Anaplasmosis.

A meeting was held on July 2, 1959, at Beltsville, Maryland, with the Animal Disease and Parasite Personnel and Animal Husbandry Personnel ? regarding Anaplasmosis research at the station near Jeanerette, Louisiana. It was agreed that no further testing would be carried out in the beef herd.

G. Two purebred Aberdeen-Angus bulls were transferred to the Iberia station from the station at Front Royal, Virginia.

Two new squeeze chutes were purchased and installed for handling the cattle.

Approximately 40 acres of marsh land on the station were reclaimed, drained and made into pasture for the beef cattle.

IV. FUTURE PLANS:

A. To continue to evaluate strains of Brahman-Angus, Africander-Angus in comparison with Brahman, Angus and first crosses of these purebreds.

B. To assess the value of Sindhi cows for the production of beef, under conditions at the Jeanerette Station, by breeding them to Angus and Brahman bulls. Also, to evaluate the progeny of Sindhi bulls out of Brahman-Angus cows and Africander-Angus cows for the production of beef.

C. Improvement of facilities: Reclamation of marshland for pasture by clearing, seeding and draining; change fences for better utilization of pastures and easier handling of cattle; improvement of drainage in all pastures.

V. PUBLICATIONS DURING THE YEAR:

Annual Report for 1958. Iberia Livestock Experiment Station, Jeanerette, Louisiana.

Paper presented at second Annual Meeting of the Animal Industry Research and Extension personnel of the Louisiana State University and A and M College, Baton Rouge, Louisiana. Development of Pure and Crossbred types o of cattle for Southeastern United States and the Gulf Coast Region.

VI. PUBLICATIONS PLANNED:

The data on the performance and carcass quality of the crossbred strain steers and the purebred steers will be published in one of the quarterly publications of the Louisiana Agricultural Experiment Station when all the information is assembled and analyzed.

Puberty of Heifer Born in 1958

Breed	No. of Heifers	Heifers in heat by 3/4/60: Number	Av. age at first heat	Wt. 10-5-59	C.S. 10-5-59	Heifers not in heat by 3/4/60: Wt. 10-5-59	C.S. 10-5-59
Brah-Ang	39	28 (72)[A]	512 days	706	6.4	674	6.7
Afri-Ang	18	12 (67)	532	690	6.2	524	5.3
Brah-Sind	8	2 (25)	690.5	650	7.3	649	6.5
Angus	1					550	8.0
Brahman	6					640	6.0

[A]Figures in parenthesis are percentages.

The table below shows the effect of line on age at puberty. There were no lines of purebred or Brahman-Sindhi heifers.

Effect of Line on Age at Puberty

Breed	Line	No. of Heifers	No. in heat by March 4, 1960	Age at 1st. heat-days.
Brah-Ang	1	4	4 (100)A	502
Brah-Ang	2	7	4 (57)	509
Brah-Ang	3	7	5 (71)	503
Brah-Ang	4	6	3 (50)	470
Brah-Ang	5	9	8 (89)	509
Brah-Ang	6	6	4 (67)	574
Afri-Ang	1	5	4 (80)	587
Afri-Ang	2	3	2 (67)	508
Afri-Ang	3	7	5 (71)	498
Afri-Ang	4	3	1 (33)	532

[A]Figures in parenthesis are percentage.

PERFORMANCE OF COW HERDS. 1959 CALVES

Iberia Livestock Experiment Station

Location	Jeanerette, Louisiana						
Line or group	Bra-Ang F_1	Ang-Bra F_1	Brahman	Angus	Ang-Sind.	Brah-Ang	Afri-Ang
Breed of sire	Brahman	Angus	Brahman	Angus	Angus	Brah-Ang	Afri-Ang
Breed of dam	Angus	Brahman	Brahman	Angus	Sindhi	Brah-Ang	Afri-Ang
No. cows calving	6	14	12	15	9	75	40
No. calves raised	4	14	6	15	9	64	35
Av. inbr. of dams(%)						4.08	9.93
Av. inbr. of calves(%)						9.37	11.94
Av. birth date	2-8-59	2-28-59	2-26-59	2-2-59	2-10-59	2-13-59	2-6-59
Av. birth wt.(lbs.)	64	66	64	64	52	66	64
Av. weaning age (days)	240	220	222	246	238	235	242
Av. weaning wt.(lbs.)	488	415	350	367	401	451	395
Av. weaning type score	8.8	8.6	6.8	10.2	8.6	8.5	7.9
Av. weaning condition score	8.3	7.7	6.0	7.9	8.0	7.3	7.0
Were calves creep fed?	No	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.75	1.64	1.38	1.30	1.70	1.68	1.47

(1) Average daily gain adjusted for sex of calf to a steer basis.

Mature Dam:		4 yr. old Dam:		3 yr. old Dam:	
Bull	0.97	Bull	1.01	Bull	1.05
Steer	1.00	Steer	1.04	Steer	1.08
Heifer	1.05	Heifer	1.09	Heifer	1.13

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Iberia Livestock Experiment Station

Location	Jeanerette, Louisiana				
Line or group	Brah-Angus	Afri-Angus	Angus	Brahman	Brah-Sind.
Breed of sire	Brah-Angus	Afri-Angus	Angus	Brahman	Brahman
Breed of dam	Bran-Angus	Afri-Angus	Angus	Brahman	Sindhi
BULLS, No.	14	7	5	3	1
Av. inbreeding (%)	7.83	16.65			
Av. initial age(days)	255	257	265	227	275
Av. initial wt.(lbs.)	495	436	458	437	535
Av. no. days on feed	154	154	154	154	154
Av. final weight	904	881	863	818	890
Av. daily gain	2.66	2.81	2.63	2.47	2.31
Av. score					
Conformation	9.6	9.9	12.2	9.9	8.6
Condition	10.6	11.2	12.5	10.9	10.0
Av. feed per day(1)	18.00	19.96	18.60	18.89	16.62
Concentrates	13.50	14.97	13.95	14.17	12.46
Roughage	4.50	4.99	4.65	4.72	4.16
Feeding regime	Ad lib.	Ad lib.	Ad lib.	Ad lib.	Ad lib.
STEERS, No.	16	14	4	3	3
Av. inbreeding(%)	9.97	15.72			
Av. initial age(days)	425	426	437	430	441
Av. initial wt.(lbs.)	528	521	492	572	517
Av. no. days on feed	203	203	203	203	203
Av. final weight	836	808	755	782	832
Av. daily gain	1.52	1.41	1.29	1.03	1.55
Av. score					
Condition	8.3	8.4	9.6	6.4	8.9
Av. feed per day(1)	14.2	14.2	14.2	14.2	14.2
Concentrates	10.6	10.6	10.6	10.6	10.6
Roughage	3.6	3.6	3.6	3.6	3.6
Feeding regime	Ad lib. in one large group on pasture				

(1) Bulls fed ad lib in individual pens. Steers fed ad lib in one group on pasture. Ration consisted of Allyce clover hay-500 lbs., Ground shelled corn no. 2-1200 lbs. and Cottonseed meal-300 lbs.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location	Jeanerette, Louisiana				
Line or group	Brah-Ang	Afri-Ang	Angus	Brahman	Brah-Sind.
Breed of sire	Brah-Ang	Afri-Ang	Angus	Brahman	Brahman
Breed of dam	Brah-Ang	Afri-Ang	Angus	Brahman	Sindhi
Sex	Heifers	Heifers	Heifers	Heifers	Heifers
Number	39	18	1	6	2
Initial (Birth - Weaning)					
Date	9-30-58	9-30-58	9-30-58	9-30-58	9-30-58
Age (days)	230	243	252	230	243
Weight (lbs.)	408	369	375	424	422
Score					
Conformation	8.8	7.7	9.2	9.1	9.9
Condition	8.1	7.3	8.5	8.7	9.2
First period - Winter (9-30-58 - 3-17-59)			Same	Same	Same
Feeding regime[1]	Limited	Same	Same	Same	Same
No. days	168	168	168	168	168
Gain per head	79	73	10	40	48
Gain per day	.47	.43	.06	.24	.29
Second period - Summer	3-17-59 -	10-5-59	Same	Same	Same
Feeding regime[2]	Pasture	Pasture	Pasture	Pasture	Pasture
No. days	202	202	202	202	202
Gain per head	210	175	165	177	208
Gain per day	1.04	0.87	0.82	0.88	1.03
Final					
Date	10-5-59	10-5-59	10-5-59	10-5-59	10-5-59
Age	600	612	622	600	614
Weight	697	617	550	640	678
Score					
Conformation	7.6	6.8	10.3	6.6	7.7
Condition	6.5	5.8	8.0	6.0	8.8
Gain per day of age	1.16	1.01	0.88	1.07	1.10

(1) All heifers fed in one group on pasture approximately four pounds of concentrates.
(2) Pasture only.

DATA ON ANIMALS SLAUGHTERED

Iberia Livestock Experiment Station

Location	Jeanerette, Louisiana				
Herd	Brah-Ang	Afri-Ang	Angus	Brahman	Brah-Sind
Breed of sire	Brah-Ang	Afri-Ang	Angus	Brahman	Brahman
Breed of dam	Brah-Ang	Afri-Ang	Angus	Brahman	Sindhi
Sex	Steer	Steer	Steer	Steer	Steer
No. slaughtered	16	14	4	3	3
Age at slaughter	630	632	644	636	647
Time in feedlot(days)	203	203	203	203	203
Gain in feedlot(lbs.)	308	287	263	210	315
Final feedlot weight	836	808	755	782	832
Slaughter weight[1]	789	770	718	742	768
Carcass weight[2]	448	442	416	431	459
Dressing percentage[3]	56.8	57.2	57.9	58.2	59.7
Slaughter grade	8.3	8.4	9.6	6.4	8.9
Carcass grade	8.1	8.0	9.4	7.2	8.1
Fat thickness over rib eye(ins.)	0.72	0.62	0.93	0.64	0.66
Rib eye area(sq. in.)	9.36	9.03	8.76	7.47	9.12
W-B Shear					
Core size	1 inch	1 inch	1 inch	1 inch	1 inch
Shear Force(lbs.)[4]	20.10	17.02	16.86	18.55	18.18
9-10-11 Rib Section					
Weight in lbs.	6.54	6.38	6.33	6.27	6.92
% Fat	27.65	24.88	32.19	24.91	28.92
% Lean	54.80	56.53	50.42	54.06	53.10
% Bone	17.55	18.59	17.38	21.03	17.98
Cooking loss as % of raw meat.	15.33	13.81	14.68	14.27	14.27

(1) Steers finished feed test on Tuesday morning, Nov. 3, 1959. They were held two days longer on feed at the station and then trucked out on Thursday morning to Swift and Company Plant 106 miles from Station. The steers were slaughtered 24 hours (Friday morning) after being trucked out. Three days elapsed from the official end of the feed test to the slaughter of the steers.

(2) Carcass weight is chilled. Swift and Company, Lake Charles, Louisiana use 1.8% of warm carcass weight to calculate chilled carcass weight.

(3) To compute the dressing percent, the slaughter weight at the packing plant just before killing the steer was obtained and the chilled carcass weight was used.

(4) Shear force is the average of six individual shears taken from the rib eye.

MD (1)

Maryland Station

by

W. W. Green

I. PROJECT: C-14 (S-10)

A Study of Productiveness of Purebred Beef Cattle in Maryland

II. OBJECTIVES:

A. To study productiveness of existing or introduced stocks of beef cattle. Productive characteristics measured will include rate of gain, economy of gain, market type, carcass quality, fertility, longevity, adaptation to environmental conditions, and other factors affecting the utility value of beef cattle.

B. To compare selective criteria (individual and pedigree) with actual performance of progeny.

C. To evaluate breeding techniques for small purebred herds under the varying conditions encountered in practice in purebred herds.

D. To attempt to produce beef cattle with superior productive capacities by line breeding and selection. (Using criteria of selection as developed in this project and by cooperating stations in this and other regions.)

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Routine weights and measurements as taken in the past were obtained on all cattle owned by the University when they were 6, 12, 24, and 48 months of age.

B. Weaning weights were obtained for 39 bull and 29 heifer calves in a cooperator's herd. All bull calves were placed on post-weaning gain-test trials; 25 on the farm and 14 at bull feeding stations.

C. A summary of weaning weights and scores was prepared for the Maryland Beef Cattle Improvement Program.

D. Records of the herd at Wye Plantation, Queenstown, Maryland, have been obtained and are being organized for study.

E. A variety of activities have been undertaken relative to a re-organization of research under this, or future projects.

IV. FUTURE PLANS:

Cooperation with the owner and manager of the Wye Plantation will be continued as well as the taking of routine measurements of cattle belonging to the University. The study of the records of Wye Plantation will progress as rapidly as possible. Until plans are completed, organization of new work will be conducted under this project.

V. PUBLICATIONS DURING THE YEAR:

Green, W. W., B. T. Whittle, and Claire L. Tharp (1960). Maryland beef cattle improvement program - Summary, 1959. Univ. Md. Agric. Expt. Sta. Misc. Pub. 373, Dept. Anim. Husb. Mimeo. A.H. 60-1, pp.13.

VI. PUBLICATIONS PLANNED:

None, unless the study of the records of Wye Plantation is completed in time.

* * * * * * *

I. SUB-PROJECT: C-14-a (S-10)

Effect of Early Weaning on the Duration of Maternal Influences in Beef Calves

II. OBJECTIVES:

A. To attempt to develop a new technique for an earlier evaluation of feed lot performance, progeny testing, and genetic evaluation of beef animals.

B. To develop sound feeding and management practices for early weaned beef calves.

C. To evaluate the calves' genetic ability to thrive under new systems of care.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Heritability of the variables was studied on the basis of 28-day feeding periods for the various weaning age and sex groups. The small number of cases involved and the nature of the data were apparently such to bring about results in which little confidence could seemingly be placed.

B. All planned analyses of the feeding data have been completed. Coefficients of multiple correlation have yet to be completed in connection with the measurement data.

C. Manuscripts for two publications are essentially complete.

IV. FUTURE PLANS:

Completion of calculations for studies presently started on the measurement data and the preparation of a manuscript.

V. PUBLICATIONS DURING THE YEAR:

Green, W. W., W. J. Corbett, and J. Buric (1959). Comparison of methods for estimating the feed used for growth and maintenance of beef calves. J. Anim. Sci. 18:548-554.

VI. PUBLICATIONS PLANNED:

Green, W. W. and J. Buric. Further studies on the comparative performance of beef calves weaned at 90 or 180 days of age.

Green, W. W. Further studies on the comparison of methods for estimating the feed used for growth and maintenance of beef calves.

PERFORMANCE OF COW HERDS. 1959 CALVES

University of Maryland Station

Location	U. of Md.	U. of Md.
Line or group	U. of Md.	U. of Md.
Breed of sire	Angus	Hereford
Breed of dam	Angus	Hereford
No. cows calving	32	22
No. calves raised	30	22
Av. inbr. of dams (%)	Outbred herd	Outbred herd
Av. inbr. of calves (%)	Outbred herd	Outbred herd
Av. birth date (living calves)	2/4/59	3/9/59
Av. birth wt. (lbs.)	60	69
Av. weaning age (days)	244	213
Av. weaning wt. (lbs.)	489	425
Av. weaning type score	13	13
Av. weaning condition score	12	13
Were calves creep fed?	Yes	Yes
Adjusted(1) av. daily gain from birth to weaning (205 days)	S-1.93 H-1.76 B-2.42	S-1.89 H-1.76

(1)Adjusted for age of dam

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains

University of Maryland Station

Location	U. of Md.	U. of Md.
Line or group	U. of Md.	U. of Md.
Breed of sire	Angus	Hereford
Breed of dam	Angus	Hereford
STEERS, No.	14	8
Av. inbreeding (%)	Outbred herd	Outbred herd
Av. initial age (days)	234	224
Av. initial wt. (lbs.)	513	484
Av. no. days on feed	252	252
Av. final weight	1018	970
Av. daily gain	2.00	1.89
Av. score		
Conformation	14	13
Condition	15	14
Av. feed per day(1)		
Concentrates	14.2	14.2
Roughage	4.9	4.9
Feeding regime	Group	Group
HEIFERS, No.	16	17
Av. inbreeding (%)	Outbred herd	Outbred herd
Av. initial age (days)	259	210
Av. initial wt. (lbs.)	501	435
Av. no. days on feed	196	196
Av. final weight	818	768
Av. daily gain	1.62	1.70
Av. score		
Conformation	14	14
Condition	14	14
Av. feed per day(1)		
Concentrates	12.5	12.5
Roughage	4.5	4.5
Feeding regime	Group	Group

(1) Both groups of steers were fed together and received alfalfa, hay, soybean oil meal and either ground or pelleted barley. Both groups of heifers were fed together and received alfalfa, hay, soybean oil meal or "mores" and either ground or pelleted barley. All calves had access to salt and a mineral mixture.

DATA ON ANIMALS SLAUGHTERED

Maryland Station

Location	U. of Md.	U. of Md.
Herd	U. of Md.	U. of Md.
Breed of sire	Angus	Angus
Breed of dam	Angus	Angus
Sex	Heifers	Heifers
No. slaughtered	7	5
Averages:		
Age at slaughter	461	427
Time in feedlot (days)	196	196
Gain in feedlot (lbs.)	310	346
Final feedlot weight	804	851
Slaughter weight(1)	485	525
Carcass weight(2)	60.3	61.4
Slaughter grade	15	15
Carcass grade	13	12
Rib eye area (sq. in.)	9.85	9.84
Conformation Grade	14	14
Finish Grade	14	14
Marbling Grade	13	12

(1) 24 hour shrinkage. Cattle had access to water only. Trucked to Baltimore (approximately 30 miles)

(2) Cold weight

(3) Final feedlot weight and cold carcass weight

Mississippi Station

by

J. C. Taylor, C. E. Lindley and B. G. Ruffin

I. PROJECT: Hatch 666 (S-10)(AHRD d1-28)

A Study to Determine the Breeding Worth of Inbred and Outbred Bulls From Various Sources.

II. OBJECTIVES:

A. To compare the growth rate, carcass qualities and maternal abilities of the progenies of bulls selected from various sources as potentially superior sires.

B. To develop a high producing herd of cows by using the progeny of good producing bulls as replacement heifers.

C. To determine the effectiveness of a selection index when used on heifers at weaning time.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Approximately a 350 cow herd made up of grade Angus, Hereford, and Shorthorn is presently being maintained on property leased from the Federal Government and located at Prairie, Mississippi.

B. Calves from 13 bull units representing 342 cows were born during the spring of 1959. Bulls used other than control bulls from the Mississippi Station were 2 Hereford bulls from the Colorado Station, 1 Hereford from the California Station, 1 Hereford and 1 Angus bull from the Oklahoma Station, 1 Montana Hereford, and 2 Angus and 1 Shorthorn bull from the Virginia Station. All calves were identified and weighed at birth. The calves were weighed and graded at weaning at which time the first five steers born in each bull unit (a total of 53 steers) were selected as tester steers and placed on winter grazing (oats and rye grass). Also 49 replacement heifers were selected from all sire units on the basis of an index which gives equal emphasis to grade and gain from birth to weaning. Weaning data is shown in the accompanying tables for the 1959 calf crop.

The 45 tester steers selected from the 1958 calf crop were on winter grazing from November 11, 1958 through May 21, 1959 at which time they were started on a fattening ration fed on native pasture. The steers were slaughtered on September 14, 1959. Final gains per day of age ranged from 1.55 to 1.69 for four Angus units and 1.59 to 1.89 for five Hereford units. Overall average daily gain for the 306 day period for the 45 steers was 1.75. Observations made at slaughter were loin eye area, carcass length, leg length, circumference of

leg, loin length, width of round, and width and depth of chest. The twelfth rib was retained from each carcass to use in testing for tenderness.

IV. FUTURE PLANS:

Project will be continued.

V. PUBLICATIONS DURING THE YEAR:

None.

VI. PUBLICATIONS PLANNED:

None.

* * * * * * * * *

by

Bryan Baker, Jr.

I. PROJECT: Hatch 642 (S-10)

Lowered Fertility in the Bovine

II. OBJECTIVES:

A. Make a survey of the reproductive performance of cattle in the Mississippi Experiment Station System.

1. Determine the reproductive efficiency for each herd of the system.

2. Determine what factors may be contributing to reproductive inefficiency.

B. To determine the nature of sterility in cows leaving the herd because of low reproductive performance.

C. Propose and test possible treatments which may increase reproductive efficiency.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. In the Mississippi Experiment Station System there are more than 1000 beef and dairy cows in the breeding herds and each year a number of these cows are replaced because they have poor reproductive performance. It is from these animals that experimental animals are secured for this study. Only cows that meet the criteria for a

hard to settle cow (as outlined in the project outline) are used. Facilities for handling the cows, examination of the reproductive tracts and ova are available.

B. The nature of such a study makes it impossible to draw any conclusions from a few years work thus only a summary of the last years activities are included.

Eight heifers that had been exposed to the bull for a three month breeding season but had not settled were run through the same routine as the cows diagnosed as sterile. The heifers did not fit the criteria set forth for a sterile cow but in order to attempt to explain why some heifers fail to settle they were bred and later slaughtered. Five of the eight had settled and had normal embryos present at the time of slaughter. The reproductive tracts of all of the heifers were normal.

Twelve cows that were classed as hard to settle were observed and bred. Of these 12 cows four settled on the first service. One case of pyometria and one case of hydrosalpinx was observed. The only gross abnormality of any of the reproductive tracts was a case of double external os of the cervix with no passage into the uterus. One resorbing embryo and one ruptured ova were observed.

IV: FUTURE PLANS:

Because it is necessary to accumulate additional data before any analyses can be attempted, this project will be continued without revision.

V. PUBLICATIONS DURING THE YEAR:

None.

VI. PUBLICATIONS PLANNED:

None.

MISS (4)

PERFORMANCE OF COW HERDS. 1959 CALVES

Mississippi Station

Location Line or group Breed of sire Breed of dam	Prairie Shorthorn 56-66 Shorthorn Shorthorn	Prairie Shorthorn 66-66 Shorthorn Shorthorn	Prairie Va. Short- horn 1339 Shorthorn Shorthorn	Prairie Pingrey Angus Angus	Prairie Va. 1195 Angus Angus	Prairie Okla. 185 Angus Angus	Prairie Va. 917 Angus Angus
No. cows calving No. calves raised	11 7	10 6	13 11	19 17	17 15	9 9	20 20
Av. birth date Av. birth wt. (lbs.)	2/19/59 68	3/21/59 71	2/24/59 75	3/14/59 68	3/12/59 63	2/20/59 60	2/25/59 61
Av. weaning age Av. weaning wt.*	231 423.2	201 456.4	226 456.3	208 424.7	210 425.8	230 435.2	225 413.8
Av. weaning type score	11.0	11.0	11.0	10.8	10.8	11.0	11.1
Were calves creep fed?	No	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning*	1.74	1.88	1.86	1.74	1.77	1.83	1.72

*Weaning weights and daily gains to weaning were adjusted to a mature dam equivalent, for sex and to a constant age of 205 days.

PERFORMANCE OF COW HERDS. 1959 CALVES

Location	Prairie	Prairie	Prairie	Prairie	Prairie	Prairie
Line or group	Colo. Royal	Colo. Brae Arden 6086	Calif. Rover 369	Okla. OK6-60	Poplarville 116	Montana 481
Breed of sire	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	12	16	24	22	18	19
No. calves raised	11	16	22	20	17	18
Av. birth date	2/24/59	3/4/59	3/22/59	3/15/59	3/8/59	3/18/59
Av. birth wt. (lbs.)	79	71	71	73	69	72
Av. weaning age	226	218	200	207	214	204
Av. weaning wt.*	458.2	423.6	431.8	435.8	428.0	439.0
Av. weaning type score	10.2	10.4	10.3	10.0	9.3	9.6
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning*	1.85	1.72	1.76	1.77	1.75	1.79

*Weaning weights and daily gains to weaning were adjusted to a mature dam equivalent, for sex and to a constant age of 205 days.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958

Location Line or group Breed of sire Breed of dam	Prairie Colo. Royal 3016 Hereford Hereford	Prairie Calif. Rover 310 Hereford Hereford	Prairie Bridwell Hereford Hereford	Prairie Natchez Hereford Hereford
Sex	Male	Male	Male	Male
Number	5	5	5	5
Initial				
Date	11/12/58	11/12/58	11/12/58	11/12/58
Age (days)	265	260	256	260
Weight (lbs.)	433.2	393.2	484.2	395.2
Score				
Conformation	11.6	11.3	11.8	10.9
First period				
Feeding regime	winter grazing	winter grazing	winter grazing	winter grazing
No. days	190	190	190	190
Gain per head	348.2	330.2	354.8	338.2
Gain per day	1.83	1.74	1.87	1.78
Second period				
Feeding regime(1)	fattening	fattening	fattening	fattening
No. days	116	116	116	116
Gain per head	211.0	230.6	224.8	184.0
Gain per day	1.82	1.99	1.94	1.59
Final period				
Date	9/14/59	9/14/59	9/14/59	9/14/59
Age	571	566	562	566
Weight	992.4	954.0	1063.8	990.8
Score				
Conformation	10.8	11.0	11.0	10.8
Gain per day of age	1.74	1.68	1.89	1.59

(1) Steers were full fed a ration of 2/3 ground shelled corn and 1/3 ground oats plus cotton seed meal.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958

Location	Prairie	Prairie	Prairie	Prairie	Prairie
Line or group	Va. 917	Prairie Queen	Pingrey	Kentucky	Colo. Brae
Breed of sire	Angus	Angus	Angus	Angus	Hereford
Breed of dam	Angus	Angus	Angus	Angus	Hereford
Sex	Male	Male	Male	Male	Male
Number	5	5	5	5	5
Initial					
Date	11/12/58	11/12/58	11/12/58	11/12/58	11/12/58
Age (days)	265	261	261	252	261
Weight (lbs.)	429.6	447.2	409.6	387.0	369.6
Score					
Conformation	12.2	10.5	10.8	11.1	10.8
First period					
Feeding regime	winter grazing				
No. days	190	190	190	190	190
Gain per head	285.8	299.6	272.6	289.6	345.2
Gain per day	1.50	1.58	1.43	1.52	1.82
Second period					
Feeding regime[1]	fattening				
No. days	116	116	116	116	116
Gain per head	175.8	211.6	197.4	213.4	241.6
Gain per day	1.52	1.82	1.70	1.84	2.08
Final period					
Date	9/14/59	9/14/59	9/14/59	9/14/59	9/14/59
Age	571	567	567	558	567
Weight	891.2	958.4	879.6	890.0	956.4
Score					
Condition	10.6	10.4	11.0	10.9	11.0
Gain per day of age	1.56	1.69	1.55	1.59	1.69

(1) Steers were full fed a ration of 2/3 ground shelled corn and 1/3 ground oats plus cotton seed meal.

DATA ON ANIMALS SLAUGHTERED

Mississippi Station

Location	Prairie	Prairie	Prairie	Prairie	Prairie
Herd	Va. 917	Prairie Queen	Pingrey	Kentucky	Colo. Brae Arden 3112
Breed of sire	Angus	Angus	Angus	Angus	Hereford
Breed of dam	Angus	Angus	Angus	Angus	Hereford
Sex	Male	Male	Male	Male	Male
No. slaughtered	5	5	5	5	5
Age at slaughter	571	567	567	558	567
Time in feedlot (days)	116	116	116	116	116
Gain in feedlot (lbs.)	1.52	1.82	1.70	1.84	2.08
Final feedlot weight	891.2	958.4	879.6	890.0	956.4
Slaughter weight(1)	895.0	961.0	856.0	867.5	947.0
Carcass weight(2)	568.8	607.6	540.0	554.6	589.4
Dressing percentage(3)	63.8	63.4	61.4	62.3	61.6
Slaughter grade	10.6	10.4	11.0	10.9	11.0
Carcass grade	11.4	10.8	11.4	11.6	9.4
Fat thickness over rib eye (ins.)	0.62	0.73	0.83	0.86	0.87
Rib eye area (sq. in.)	10.23	10.25	9.92	10.37	10.49
Marbling score	5.6	7.0	5.6	5.8	8.8
Carcass length	44.92	44.72	45.20	44.86	45.36
Leg length	27.60	28.82	27.54	27.72	29.08
Circumference of round	33.50	32.96	30.32	33.60	33.48
Width of round	10.08	10.08	9.78	9.74	10.34
Loin length	23.34	24.12	25.20	23.20	23.90
Width of chest	8.35	8.52	8.25	8.42	8.32
Depth of chest	15.13	16.38	16.13	15.92	16.59

(1) Steers were weighed off feed during early morning loaded on trucks and hauled to slaughter plant where they were killed at 1:00 p.m. on the same day.
(2) Hot weight used.
(3) Final feed lot weights and hot carcass weights were used to calculate the dressing percentage.

DATA ON ANIMALS SLAUGHTERED

Mississippi Station

Location Herd Breed of sire Sex	Prairie Colo. Royal 3016 Hereford Male	Prairie Calif. Rover 310 Hereford Male	Prairie Bridwell Hereford Male	Prairie Natchez Hereford Male
No. slaughtered	5	5	5	5
Age at slaughter	571	566	562	566
Time in feedlot (days)	116	116	116	116
Gain in feedlot (lbs.)	1.82	1.99	1.94	1.59
Final feedlot weight	992.4	954.0	1063.8	900.8
Slaughter weight(1)	990.0	943.0	1059.0	915.0
Carcass weight(2)	628.6	592.0	665.2	566.0
Dressing percentage(3)	63.3	62.0	62.5	62.8
Slaughter grade	10.8	11.0	11.0	10.8
Carcass grade	9.6	9.2	9.4	9.4
Fat thickness over rib eye (ins.)	0.69	0.71	0.64	0.71
Rib eye area (sq. in.)	10.83	10.49	11.55	9.90
Marbling score(4)	8.6	8.0	8.2	8.2
Carcass length	47.06	46.56	47.72	45.34
Leg length	29.54	29.32	30.30	28.60
Circumference of round	32.68	34.48	35.72	33.14
Width of round	10.40	10.16	10.52	10.18
Loin length	24.34	25.98	25.12	23.92
Width of chest	8.88	8.42	8.77	7.99
Depth of chest	16.36	16.79	17.19	16.70

(1) Steers were weighed off feed during early morning loaded on trucks and hauled to slaughter plant where they were killed at 1:00 p.m. on the same day.
(2) Hot weight used.
(3) Final feed lot weights and hot carcass weights were used to calculate the dressing percentage.
(4) 1 through 12 according to USDA grade standards, with one extremely abundant and 12 void.

Two State Projects at the Mississippi Station which contribute information on the performance of different types of cattle and procedures that will be useful in measuring performance are as follows:

I. PROJECT: 645

A Study to Determine the most Profitable Type of Cattle under Mississippi Conditions

II. OBJECTIVE:

To determine which of three types of cattle, large, intermediate or small, is the most suitable for beef production in Mississippi.

III. RESULTS:

The initial breeding groups were formed in the spring of 1959 and the first calf crop born in 1960.

IV. FUTURE PLANS:

It is expected that the project will continue for several years.

* * * * * *

I. PROJECT: 646

A Study of the Effect of Several Feeding and Management Practices on the Carcass Quality of Beef Steers under Mississippi Conditions

II. NATURE OF WORK:

Seven lots of 6 beef steers were placed on experiment to determine the system of feeding and management which would produce the most acceptable carcass the most efficiently. The lots were handled as follows:

Lot 1 Weanling steers killed at weaning.
Lot 2 Weaned, winter grazed and killed.
Lot 3 Weaned, winter grazed, fed 75-90 days and killed.
Lot 4 Weaned, fed as stockers, spring and summer grazed, winter grazed, and killed.
Lot 5 Weaned, fed as stockers, spring grazed, fed in drylot and killed.
Lot 6 Weaned, fed as stockers, spring grazed, fed on pasture and killed.
Lot 7 Weaned, fed as stockers, spring and summer grazed, fed in drylot and killed.

III. RESULTS:

Data collected on lots 1, 2, and 3 show averages as follows:

Lot	Live Weight	Dressing %	Carcass Grade	Rib eye area	Fat cover 12th rib (in.)
1	421	54.0	8.3	5.50	.28
2	698	57.2	8.3	8.79	.60
3	881	61.4	10.3	10.14	.84

The 6-7-8 rib section from each steer was frozen and will be used for palatability studies.

IV. FUTURE PLANS:

This work will be continued another year with all lots except 1, included.

North Carolina Station

by

J. H. Gregory

I. PROJECT: Anim. Indus. H 198 (S-10)(AHRD d1-23)

Genetic and Environmental Interactions for Performance and Carcass Traits in Beef Cattle

II. OBJECTIVES:

A. To evaluate the importance of sire-by-location interactions for performance traits.

B. To evaluate sire-by-location and ration interaction for gain and carcass characteristics of steer progeny.

C. To develop and evaluate selection criteria for the improvement of productive efficiency and market quality.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. This project was revised this year from the existing project "The Improvement of Beef Cattle Through Breeding." In the spring of 1959 there were 62 purebred Hereford females at Raleigh, N. C., 47 grade Hereford females at Laurel Springs, N. C. and 57 grade Hereford females at Plymouth, N. C.

In the spring of 1960 another grade Hereford herd of 65 cows at Butner, N. C. was incorporated into the project. This will give three locations for the carcass measurements of steers of different altitudes, temperature and rainfall.

B. The herds at Laurel Springs and Plymouth were artificially bred with the use of frozen semen. There was a low conception rate due to the inability to get a high quality semen freeze from one of the bulls. In 1960 all herds are being bred artificially.

IV. FUTURE PLANS

To continue the project as it is now being operated.

V. PUBLICATIONS DURING THE YEAR:

None

VI. PUBLICATIONS PLANNED:

None

PERFORMANCE OF COW HERDS. 1959 CALVES

North Carolina Stations

Location Line or group Breed of sire Breed of dam	Plymouth Hereford Hereford Hereford	Raleigh Hereford Hereford Hereford	Raleigh Angus Angus Angus	Raleigh Shorthorn Shorthorn Shorthorn	Laurel Spgs Hereford Hereford Hereford
No. cows calving	51	41	25	13	41
No. calves raised	49	39	24	11	40
Av. birth date	2-13-59	1-9-59	1-6-59	1-19-59	3-6-59
Av. birth wt. (lbs.)	63.64	55.7	54	63	60
Av. weaning age (days)	272	234	237	224	210
Av. weaning wt. (lbs.)	446	400	440	395	334
Av. weaning type score	10.16	9.8	11.09	10.9	9.4
Were calves creep fed?	No	No	No	No	No
Adjusted av. daily gain from birth to weaning (1)	1.47	1.54	1.7	1.6	1.38

(1) Plymouth - Adjusted 25 lbs. for heifers, 20 lbs. for 4 year old cows and 35 lbs. for 3 year old cows.
Raleigh - Shorthorn and Hereford had severe cases of pink eye during most of summer. Adjusted av. daily gain same at all three stations.

NC (3)

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Central Station

Location	Raleigh	Raleigh	Raleigh
Line or group	Hereford	Angus	Shorthorn
Breed of sire	Hereford	Angus	Shorthorn
Breed of dam	Hereford	Angus	Shorthorn
BULLS, No.	12	5	4
Av. initial age (days)	247	255	250
Av. initial wt. (lbs.)	467	547	473
Av. no. days on feed	168	168	168
Av. final weight	770	860	760
Av. daily gain	1.8	1.86	1.70
Av. score			
Conformation	11.67	12.33	11.25
Condition	9.33	10.00	9.00
Av. feed per day			
Concentrates	18 lb.	18 lb.	18 lb.
Roughage	15 silage	15 silage	15 silage
HEIFERS, No.	16	10	2
Av. initial age (days)	280	285	280
Av. initial wt. (lbs.)	400	473	472
Av. no. days on feed	168	168	168
Av. final weight	608	700	707
Av. daily gain	1.24	1.35	1.4
Av. score			
Conformation	11.00	11.67	11.5
Condition	8.67	9.00	9.0
Av. feed per day			
Concentrates	12	12	12
Roughage	5	5	5

Rations used for bulls and heifers as follows: 1100 lb. Ground ear corn. 575 lb. Grown corn cobs, 100 lb. Alfalfa meal, dehydrated, 200 lb. soybean oil meal, 12 lb. Defluorinated phosphate, 6 lb. Limestong, 7 lb. Trace mineralized salt. Bulls and heifers were fed once per day a full feed. Both were pastured on accumulated fescue pasture.

DATA ON ANIMALS SLAUGHTERED

Location	Raleigh
Breed of sire	Hereford
Breed of dam	Hereford
Sex	Steers
No. slaughtered	21
Age at slaughter	624 days
Time in feedlot (days)	154
Gain in feedlot (lbs.)	405.5
Final feedlot weight	1065
Slaughter weight	1004
Carcass weight	594
Dressing percentage	59.2
Slaughter grade	10.1
Carcass grade	10.5

South Carolina Station

by

W. C. Godley

I. PROJECT: SC 479 (S-10)

The Response of Sire Progenies to Management and Feeding Procedures

II. OBJECTIVE:

To investigate the response of sire progenies, as measured by live animal and carcass traits, to methods of producing slaughter cattle; and to evaluate the magnitude and importance of the average genotype with certain environmental influences.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. One hundred and two calves were produced during the 1959 calving season. The fifty-eight purebred Angus calves are the progeny of six bulls, and the forty-four purebred Hereford calves were sired by three bulls. At weaning, an index (equal weight for gain from birth to weaning, and weaning grade) was computed for each individual. An average of the indices for each sire's progeny shows considerable differences between progeny groups as indicated by a range from 94.5 to 129.7. A calf that graded middle good and gained 1.7 pound per day would have an index of 100.

B. Nine bull calves were selected as possible herd sires and are presently on a R.O.P. feeding test. All other males were castrated and the steers and heifers put on postweaning feeding trials. On the basis of the weaning indices, one Hereford bull was eliminated from the breeding herds.

C. Fifteen Angus and sixteen Hereford steers that were calved in 1958 and representing six sire groups were fed for approximately 90 days after we weaning. These steers were slaughtered and detailed carcass data were obtained including observations on carcass composition, sensory evaluations and shear values of representative cuts.

D. This project was approved during the year and sufficient data are not available from which to draw conclusions; however, present data indicate that sire progenies differ in both live animal and carcass traits. These differences are important to both the commercial and purebred producers.

IV. FUTURE PLANS:

The work will continue next year on a similar basis. Emphasis will be placed on increasing the size of the Hereford herds at the College and at the Coast Experiment Station.

V. PUBLICATIONS DURING THE YEAR:

Godley, W. C., E. G. Godbey, E. D. Kyzer and R. F. Wheeler. 1960. Crossbred and purebred dams for the production of slaughter calves. J. Anim. Sci. 19:203.

VI. PUBLICATIONS PLANNED:

None.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

South Carolina Agricultural Experiment Station

Location	Clemson	Clemson	Clemson	
Line or group	I	II	III	
Breed of sire	*	*	*	
Breed of dam	*	*	*	
STEERS, No.	10	10	11	
Av. initial age (days)	392.5	375.0	389.1	
Av. initial wt. (lbs.)	580.0	587.5	589.1	
Av. no. days on feed	92.5	88.2	89.1	
Av. final weight	806.8	749.5	756.7	
Av. daily gain	2.45	1.84	1.88	
Av. feed per day(1)	8.67	7.86	7.63	
Concentrates	13.49	.65		
Roughage	4.24			
Feeding regime	Dry lot	Past. + Grain	Past. only	

*Both Purebred Angus and Hereford steers were used in each treatment. Group I full fed (50% corn, 32% oats, cottonseed hulls free choice, 16% cottonseed meal, 1% Coastal Bermuda pellets and 1% Kalcite. Group II grazed Rye grass and Crimson clover and full fed ground snapped corn. Group III grazed Rye grass and Crimson clover with no supplementing grain.

PERFORMANCE OF COW HERDS. 1959 CALVES

South Carolina Agricultural Experiment Station

Location Line or group Breed of sire Breed of dam	Clemson D. D. Hereford Hereford	Clemson G. M. Hereford Hereford	Clemson I. M. Angus Angus	Clemson C. K. Angus Angus	Clemson Evader Angus Angus
No. cows calving	11	13	11	7	12
Av. birth date	1/30/59	2/5/59	1/29/59	1/8/59	1/31/59
Av. birth wt. (lbs.)	64.9	7.14	60.09	57.9	58.7
Av. weaning age	210 days	210 days	210 days	210 days	210 days
Av. weaning wt.	407.73	421.38	421.82	415.71	402.50
Av. weaning type score	12.64	11.85	12.27	11.43	11.75
Were calves creep fed?	*	*	*	*	*
Adjusted(1) av. daily gain from birth to weaning	1.83	1.72	1.79	1.93	1.75

Location Line or group Breed of sire Breed of dam	Summer-ville J. M. Hereford Hereford	Summer-ville D. D. Hereford Hereford	Summer-ville C. K. Angus Angus	Summer-ville C. A. Angus Angus	Summer-ville G-14 Angus Angus
No. cows calving	16	7	6	13	21
No. calves raised	15	6	5	10	18
Av. birth date	1/29/59	1/20/59	2/9/59	2/2/59	2/6/59
Av. birth wt. (lbs.)	69.6	62.5	64.5	64.3	77.3
Av. weaning age	210 days	210 days	210 days	210 days	210 days
Av. weaning wt.	359.47	396.17	413.60	438.00	469.66
Av. weaning type score	10.27	12.17	10.60	10.30	11.33
Sere calves creep fed?	*	*	*	*	*
Adjusted(1) av. daily gain from birth to weaning	1.53	1.73	1.94	1.92	1.99

(1)Adjusted for sex, age of dam and creep feeding.
*One-half of the calves in each group were creep fed.

DATA ON ANIMALS SLAUGHTERED

South Carolina Agricultural Experiment Station

Location Herd	Clemson Dry Lot	Clemson Pasture + Grain	Clemson Pasture only	
Breed of sire	*	*	*	
Breed of dam	*	*	*	
Sex	Steers	Steers	Steers	
No. slaughtered	10	10	11	
Age at slaughter	485	463.2	478.2	
Time in feedlot (days)	92.5	88.2	89.1	
Gain in feedlot (lbs.)	226.8	162.0	167.6	
Final feedlot weight	806.8	749.5	756.7	
Slaughter weight(1)	773.3	737.2	753.5	
Carcass weight(2)	461.4	431.9	426.9	
Dressing percentage(3)	59.68	58.45	57.17	
Slaughter grade	8.67	7.86	7.63	
Carcass grade	8.8	8.1	7.4	
Rib eye area (sq. in.)	9.30	9.61	9.96	
W-B Shear				
Core size	1"	1"	1"	
Shear Force (lbs.)	16.2	15.7	15.8	
9-10-11 Rib Section				
Weight in lbs.	6.99	6.39	6.32	
% Fat (Separable)	33.34	26.49	24.24	
% Lean	49.49	54.91	55.82	
% Bone	17.17	18.60	19.94	
Other observations on carcass:				
% Cooking Loss	22.47	22.59	22.90	
Roast Score*	6.87	6.83	6.71	
Steak Score*	6.88	6.71	6.34	
*Hedonic Scale				

(1) Off feed 24 hours prior to slaughter - access to water.
(2) Hot carcass (No shrink).
(3) Weight at slaughter and hot carcass weight.
*Purebred Angus and Hereford steers were allotted to treatments at random within sire groups.

Tennessee Station

-by-

C. S. Hobbs

I. PROJECT: Hatch 61 (S-10)

The Improvement of the Producing Ability of Beef Cattle.

II. OBJECTIVES:

A. To develop lines or line crosses, or combinations of lines and crosses of beef cattle which will make the most efficient use of Tennessee pastures and forages and that will result in an improvement of such characters as rate of gain, economy of gain, carcass quality, fertility and longevity.

B. To develop effective breeding techniques for the improvement of existing lines of beef cattle.

C. To investigate the productivity of existing lines of beef cattle.

D. To investigate the effect of different levels of nutrition on the development of type and conformation, on economy of gain, fertility and longevity.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and animals.

1. A total of approximately 960 cows are included in the project and are located at various stations in the state as follows:

Station	Approximate No. Cows	Breed
Tobacco Expt. Sta., Greeneville	75	Polled Hereford
Main Station, Knoxville	35	Angus
	25	Hereford
Alcoa Unit, Alcoa	225	Hereford
UT-AEC Laboratory, Oak Ridge	200	Polled Hereford
Plateau Expt. Sta., Crossville	100	Angus
Middle Tennessee Expt. Sta., Spring Hill	65	Hereford
Highland Rim Expt. Sta., Springfield	35	Hereford
Ames Plantation, Grand Junction	200	Angus

2. During 1959 two Hereford bulls and four Angus bulls were purchased. Breeding interest was also obtained in one Hereford and one Angus bull. Fifty-nine Hereford and three Angus females were purchased during the year.

3. The UT-AEC project is under going revision and the cow herd is being replaced by yearling heifers (100 in the fall of 1960 and 100 in the fall of 1961) which have been exposed to various

amounts of radiation. These cows will then be used to progeny test 2-year old bulls. Their offspring will be placed on a postweaning feed test, slaughtered, and carcass information obtained.

B. Research Results:

1. Performance data were collected on all the beef cattle in the station herds. Records from birth to weaning were obtained for about 700 calves. These included birth weights, weights and grades when the calves were about four months old, and weights and grades at weaning. These data provided progeny test information on 28 Hereford sires and 13 Angus sires, and are summarized in the accompanying tables.

2. At weaning time 27 Hereford and 16 Angus bull calves were selected on the basis of their type grade and adjusted daily gain to be placed on a postweaning gain evaluation test. Half of the bulls were put on a full feed for the winter and half were limited fed. The winter period is to be followed by a pasture period in the spring and early summer, both with and without grain, and a standard full feed test for about 100 days.

3. Nineteen Hereford and 14 Angus yearling bulls wintered on two levels of feeding in the winter of 1958-59 completed the pasture and full feed phases of their postweaning performance tests. Also at Ames Plantation 30 yearling Angus bulls completed similar grazing and full feed phases of postweaning tests.

4. Carcass data were secured on 57 yearling Hereford steers by 10 sires and 19 yearling Angus steers by 5 sires. The carcass data collected includes the grade, several measurements, and a detailed study of one rib cut from each carcass. Physical separation data, shear score, and taste panel evaluations were obtained from each rib cut. These data are summarized by sire groups in the accompanying tables.

IV: FUTURE PLANS:

A. Continue the development of lines and herds at the main station and substations with emphasis on performance selection.

B. Continue the evaluation of cow productivity in all herds including c alf gains, grades and indexes at 120 days and at weaning as measures of calf performance and cow productivity.

C. Continue the performance and progeny testing of sires. This will involve a continuation of the comparison between full and limited feeding during the wintering period after weaning followed by several months on pasture, both with and without grain, and a full feed period of about 100 days to determine the best method of evaluating growth and development of bulls.

D. Continue and expand the carcass evaluation work to provide additional progeny test information on sires. Also the carcass data will be used to determine which measures are most useful in evaluating carcass merit.

V. PUBLICATIONS DURING THE YEAR:

High, Joe W., H. J. Smith and C. S. Hobbs. 1959. The relationship of 120-day and weaning daily gains of beef calves. Proc. Assn. of S. Agr. Workers. Fifty-sixth Annual Conv., Memphis, Tenn.

VI. PUBLICATIONS PLANNED:

Results of the work will be published as justified.

VII. PERSONNEL ACTIVE IN THE PROJECT:

C. S. Hobbs, H. J. Smith, J. W. High, Ralph Dodson, J. W. Cole, R. J. Cooper and C. M. Kincaid, Knoxville; R. A. Reynolds and J. M. Bird, Oak Ridge; J. H. Felts, Greeneville; J. A. Odom, Crossville; L. M. Safley, Springfield; E. J. Chapman, Spring Hill; and J. B. McLaren, Grand Junction, Tennessee.

* * * * * * * *

I. PROJECT: Hatch 65 (S-10)

The Detection of Animals Heterozygous for Recessive Bovine Dwarfism.

II. OBJECTIVES:

A. To investigate methods of identifying animals heterozygous for recessive bovine dwarfism.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. X-Ray Studies

X-rays were taken of the lumbar vertebrae of 319 calves during the year. A comparison of the classifications of the X-rays taken in 1959 and those taken in previous years in the project for carrier and assumed clean calves are given below.

	No. Calves	X-ray Classification[1]							
		C	B_2	B_3	B_4	B_5	B_6	B_7	B_8
Carriers 1959	11	-	2	4	1	3	1	-	-
1954-57	83	15	34	7	11	9	3	3	1
Assumed Clean 1959	112	44	29	15	14	4	2	2	2
1954-57	210	128	57	16	6	-	2	1	-

[1] The classifications of X-rays ranged from "C" (normal) through "B_1 to B_8" (progressive degrees of abnormality) to "A" (typical abnormality observed in dwarfs.

These results show that 79 of the 94 known carriers (84%) had abnormal or B type X-rays. However, only 172 of the 322 calves (53%) which should have been clean on the basis of their pedigrees had normal or C type X-rays. When the 112 assumed clean calves X-rayed previously, a smaller proportion were classified C (39% compared to 61%) and a larger proportion were classified B_4 to B_8 (21% compared to 4%).

B. A group of 30 pedigree clean Hereford cows is being maintained with half of them mated artificially to a dwarf bull and half of them mated to a pedigree clean bull each year. In 1959 16 clean and 8 carrier calves were produced. These calves were included in the X-ray studies mentioned previously. Also six body measurements were taken at less than two weeks, 4 months, and 6 1/2 months of age. The assumed clean calves were about two inches taller at the withers with about 0.5 inch longer cannons at all three ages than carrier calves of the same sex. Also the clean calves tended to be longer bodied. The clean calves were about 10 lb. heavier at birth and 30 lb. heavier at 4 and 6 1/2 months than the carriers. The cows were mated to different clean and swarf bulls for 1960 calves.

Parathyroid hormone was administered to 4 carrier and 4 clean calves to see if they differed in their ability to mobilize calcium from their bone. At the levels of hormone used little change in the level of serum calcium was observed in either group. A drop in serum inorganic phosphorus was observed in both groups with little difference between genotypes.

IV. FUTURE PLANS:

A. The herd of 30 cows will be maintained with one-half of the herd mated to a dwarf bull one year and to a pedigree clean bull the next year and the other half mated to a bull of the opposite genotype each year.

B. Calves from the above matings will be X-rayed before two weeks of age and body measurements will be taken when X-rayed, when approximately 4 months old and at weaning. The osmotitic fragility of the red blood cells will be measured at each of the three ages also.

C. The effects of various levels of parathyroid hormone on carrier and clean calves will be investigated in more detail. The changes in calcium, inorganic phosphorus, alkaline phosphatase, and citric acid in the serum following injections of parathyroid hormone will be observed.

D. Other possible indicators of genotype will be tested on the animals of known genotype that are available.

V. PUBLICATIONS DURING THE YEAR:

High, J. W., Jr., H. J. Smith, C. M. Kincaid and C. S. Hobbs. 1959. Evaluation of the X-ray method of detecting animals heterozygous for Snorter dwarfism. J. Anim. Sci. 18: 1438-1446.

VI. PUBLICATIONS PLANNED:

None

VII. PERSONNEL ACTIVE IN THE PROJECT:

R. J. Cooper, R. A. Reynolds, H. J. Smith, C. S. Hobbs and C. M. Kincaid.

PERFORMANCE OF COW HERDS. 1959 CALVES

Tennessee Station

Location	Alcoa, Tennessee					
Line or group	9075	2825	9217	9023	4033	2623
Breed of sire	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	20	23	20	20	33	27
No. calves raised[a]	16	12	17	16	25	20
Av. birth date	2-17-59	2-13-59	2-13-59	2-20-59	2-12-59	2-20-59
Av. birth wt. (lbs.)	70	77	72	71	73	72
Av. weaning age	234	238	238	220	239	227
Av. weaning wt.	502	513	489	456	492	468
Av. weaning type score	12.9	12.1	12.4	12.2	12.1	11.9
Av. weaning condition score	9.1	10.0	10.1	9.9[b]	9.6	9.9[c]
Were calves creep fed?	No	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.96	1.98	1.88	1.88	1.83	1.84

(1) Adjusted for sex and age of dam.

a Some calves not included as raised because they were sold, raised on foster dams, or transferred to another project before the weaning data were obtained.

b. Five animals not graded

c Three animals not graded

d Two animals not graded

PERFORMANCE OF COW HERDS. 1959 CALVES

Tennessee Station

Location	Alcoa	Alcoa	Alcoa	OakRidge	OakRidge	OakRidge
Line or group	9416	2914	2974	9542	9508	9351
Breed of sire	Hereford	Hereford	Hereford	P.Hereford	P.Hereford	P.Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	20	6	6	20	28	30
No. calves raised	18	4	4	19	25	30
Av. birth date	2-25-59	3-24-59	3-24-59	2-17-59	2-16-59	2-17-59
Av. birth wt. (lbs.)	73	59	49	68	69	66
Av. weaning age	229	198	198	239	239	238
Av. weaning wt.	435	360	305	474	489	470
Av. weaning type score	11.9	10.8	10.9	11.9	11.4	11.6
Av. weaning condition score	9.6[d]	8.6	7.8	9.7	9.7	9.9
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.73	1.79	1.55	1.83	1.91	1.82

Location	OakRidge	OakRidge	OakRidge	OakRidge	OakRidge	OakRidge
Line or group	9118	9755	9119	9988	9067	0001
Breed of sire	P.Hereford	P.Hereford	P.Hereford	P.Hereford	P.Hereford	Herf x Ang dwarf
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	18	18	18	17	21	8
No. calves raised[a]	16	16	18	16	16	8
Av. birth date	3-4-59	3-21-59	2-20-59	3-10-59	3-15-59	3-7-59
Av. birth wt. (lbs.)	67	63	69	61	75	64
Av. weaning age	224	207	236	217	212	220
Av. weaning wt.	419	368	436	398	460	434
Av. weaning type score	11.6	11.1	11.3	11.1	11.2	11.6
Av. weaning condition score	9.6	9.3	9.5	9.3	9.5	10.0
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain						

PERFORMANCE OF COW HERDS. 1959 CALVES

Tennessee Station

Location	Greeneville	Greeneville	Greeneville	Springfield	Springfield	Columbia
Line or group	3180	9983	9717	9156	6955	9505
Breed of sire	P.Hereford	P.Hereford	P.Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	10	18	13	25	7	19
No. calves raised[a]	9	17	8	22	7	18
Av. birth date	3-19-59	3-12-59	3-13-59	3-15-59	5-24-59	3-13-59
Av. birth wt. (lbs.)	76	71	57	65	62	73
Av. weaning age	201	208	207	236	150	221
Av. weaning wt.	465	451	385	464	314	431
Av. weaning type score	11.2	11.6	11.1	12.2	10.8	11.7
Av. weaning condition score	8.0	8.0	7.6	9.6	8.5	8.3
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	2.07	1.92	1.88	1.84	1.93	1.70

Location	Columbia	Columbia	Knoxville	Knoxville	Crossville	Crossville
Line or group	6432	2892	9618	9137	5026	5063
Breed of sire	Hereford	Hereford	Hereford	Angus	Angus	Angus
Breed of dam	Hereford	Hereford	Hereford	Angus	Angus	Angus
No. cows calving	18	10	20	36	20	27
No. calves raised[a]	18	9	5	28	17	26
Av. birth date	2-28-59	3-25 59	3-28-59	3-5-59	3-2-59	2-24-59
Av. birth wt. (lbs.)	71	60	68	57	65	57
Av. weaning age	234	209	201	223	239	245
Av. weaning wt.	428	326	397	431	507	480
Av. weaning type score	10.6	10.2	11.3	12.4	11.7	12.3
Av. weaning condition score	7.8	6.4			9.6	9.9
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.64	1.52	1.80	1.81	1.94	1.85

PERFORMANCE OF COW HERDS. 1959 CALVES

Tennessee Station

Location	Crossville	Crossville	Crossville	Ames	Ames	Ames
Line or group	5244	5226	9186	1084	9380	9385
Breed of sire	Angus	Angus	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus	Angus	Angus
No. cows calving	27	4	11	27	23	27
No. calves raised[a]	24	4	9	22	21	21
Av. birth date	3-8-59	2-21-59	3-6-59	2-8-59	2-23-59	2-8-59
Av. birth wt.(lbs.)	61	58	65	56	59	55
Av. weaning age	233	248	235	265	250	265
Av. weaning wt.	455	461	439	455	447	472
Av. weaning type score	12.0	12.0	12.0	11.9	11.7	12.2
Av. weaning condition score	10.2	10.0	9.4	9.5	9.8[e]	9.6[e]
Were calves creep fed?	No	No	No	No	No	No
Adjusted av. daily gain from birth to weaning	1.88	1.85	1.79	1.68	1.71	1.65

Location	Ame	Ames	Ames	Ames	Ames	
Line or group	9305	9295	9044	9137	9291	
Breed of sire	Angus	Angus	Angus	Angus	Angus	
Breed of dam	Angus	Angus	Angus	Angus	Angus	
No. cows calving	13	27	11	9	23	
No. calves raised[a]	9	23	6	7	19	
Av. birth date	3-29-59	2-19-59	2-24-59	2-23-59	2-22-59	
Av. birth wt.(lbs.)	53	56	62	57	52	
Av. weaning age	216	254	249	250	251	
Av. weaning wt.	363	446	420	403	381	
Av. weaning type score	11.2	11.2	11.8	11.5	10.5	
Av. weaning condition score	8.6	8.3[e]	8.3	8.7	8.2	
Were calves creep fed?	No	No	No	No	No	
Adjusted av. daily gain from birth to weaning	1.64	1.62	1.48	1.49	1.51	

[e]One animal not graded.

Tenn (10)

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location Line or group Breed of sire Breed of dam	Knoxville High Level Hereford Hereford	Knoxville Low Level Hereford Hereford	Knoxville High Level Angus Angus	Knoxville Low Level Angus Angus
Sex	Bulls	Bulls	Bulls	Bulls
Number	8	12	7	8
Initial				
Date	11-24-58	11-24-58	11-24-58	11-24-58
Age (days)	268	279	270	260
Weight (lbs.)	530	567	526	520
Score				
Conformation	12.4	12.6[a]	13.7	13.2
Condition	9.0	8.9[a]	10.1[b]	10.2[c]
First period				
Feeding regime	High Level[1]	Low Level[2]	High Level[1]	Low Level[2]
No. days	134	134	134	134
Gain per head	315	274	308	269
Gain per day	2.35	2.04	2.29	2.01
Second period				
Feeding regime	Pasture	Pasture[d]	Pasture[d]	Pasture
No. days	122	122	122	122
Gain per head	102	149	78	85
Gain per day	0.84	1.22	0.64	0.70
Third period				
Feeding regime	3	4	3	4
No. days	98	98	98	98
Gain per head	281	280	227	287
Gain per day	2.86	2.85	2.31	2.93
Final				
Date	11-13-59	11-13-59	11-13-59	11-13-59
Age	622	631	624	613
Weight	1227	1257	1138	1148
Score				
Conformation	12.7	12.7	11.4	12.3
Condition	10.4	10.2	9.7	10.5
Gain per day of age	1.85	1.88	1.71	1.77

(1) Av. daily ration per head was approximately 10 lb. ground shelled corn, 12 lb. corn silage, 2 lb. alfalfa hay and 1 1/2 lb. CSM.

(2) Av. daily ration was approximately 4 lb. ground shelled corn, 27 lb. corn silage, 2 lb. alfalfa hay and 1 1/2 lb. CSM.

(3) Fed all they would consume of a mixture of about 61% ground ear corn, 30% alfalfa hay, 8% CSM, plus molasses, salt, and dical phosphate. Av. daily consumption for "3" groups was 30 lb. and for "4" groups was 28 lb.

a Does not include one bull bought.

b. Two bulls not graded

c Three bulls not graded

d One bull removed from lot at end of winter period.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location	Ames	Alcoa	Alcoa	Alcoa
Line or group		9046	9505	4033
Breed of sire	Angus	Hereford	Hereford	Hereford
Breed of dam	Angus	Hereford	Hereford	Hereford
Sex	Bulls	Steers	Steers	Steers
Number	26	12	1	2
Initial				
Date	10-20-58	9-29-58	9-29-58	9-29-58
Age (days)	231	220	162	256
Weight (lbs.)	479	485	360	545
Score				
Conformation	12.4	12.2	12.8	12.5
Condition	9.3	9.1	9.0	8.5
First period				
Feeding regime	Moderate Level	1	1	1
No. days	173	185	185	185
Gain per head	213	191	211	178
Gain per day	1.23	1.03	1.14	.96
Second period				
Feeding regime	Pasture	Pasture	Pasture	Pasture
No. days	95	135	135	135
Gain per head	168	169	190	146
Gain per day	1.77	1.25	1.41	1.08
Third period				
Feeding regime		2	2	2
No. days	125	82	82	82
Gain per head	220	193	205	125
Gain per day	1.76	2.36	2.50	1.52
Final				
Date	11-17-59	11-5-59	11-5-59	11-5-59
Age	624	622	564	658
Weight	1080	1036	965	1070
Score				
Conformation	12.5		12.0	11.0
Condition	8.4	10.6		
Gain per day of age	1.63	1.55	1.59	1.52

[1]Group fed an average of 5 lb. corn and cob meal, 1 lb. CSM, 4-5 lb. mixed legume grass hay and a full feed of grass silage.
[2]Implanted with 24 mg. stilbestrol and full fed a mixed feed consisting mostly of ground ear corn while still on pasture.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location Line or group Breed of sire Breed of dam	Alcoa 9075 Hereford Hereford	Alcoa 9416 Hereford Hereford	Alcoa 9023 Hereford Hereford	Alcoa 9217 Hereford Hereford
Sex	Steers	Steers	Steers	Steers
Number	12	2	11	5
Initial				
Date	9-29-58	9-29-58	9-29-58	9-29-58
Age (days)	214	162	227	230
Weight (lbs.)	536	402	506	480
Score				
Conformation	12.7	12.5	12.8	12.5
Condition	9.0	9.5	9.7	8.9
First period				
Feeding regime	1	1	1	1
No. days	185	185	185	185
Gain per head	185	220	155	192
Gain per day	1.00	1.19	0.84	1.04
Second period				
Feeding regime	Pasture	Pasture	Pasture	Pasture
No. days	135	135	135	135
Gain per head	174	170	176	155
Gain per day	1.29	1.26	1.30	1.15
Third period				
Feeding regime	2	2	2	2
No. days	82	82	82	82
Gain per head	210	226	195	187
Gain per day	2.56	2.76	2.38	2.28
Final				
Date	11-5-59	11-5-59	11-5-59	11-5-59
Age	616	564	628	632
Weight	1097	1018	1032	1015
Score				
Conformation	10.9	11.2		11.2
Condition			10.8	
Gain per day of age	1.64	1.66	1.52	1.50

[1]Group fed an average of 5 lb. corn and cob meal, 1 lb. CSM, 4-5lb. mixed legume grass hay and a full feed of grass silage.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location Line or group Breed of sire Breed of dam	Alcoa 9120 Hereford Hereford	Alcoa 9000 Hereford Hereford	Alcoa 9611 Hereford Hereford	Crossville 5244 Angus Angus
Sex	Steers	Steers	Steers	Steers
Number	8	2	5	5
Initial				
Date	9-29-58	9-29-58	9-29-58	10-1-58
Age (days)	202	256	237	221
Weight (lbs.)	393	508	533	488
Score				
Conformation	11.8	11.8	12.9	11.6
Condition	8.5	9.0	9.3	9.1
First period				
Feeding regime	1	1	1	1
No. days	185	185	185	208
Gain per head	196	181	191	165
Gain per day	1.06	0.98	1.03	0.79
Second period				
Feeding regime	Pasture	Pasture	Pasture	Pasture
No. days	135	135	135	88
Gain per head	169	143	171	72
Gain per day	1.25	1.06	1.27	0.82
Third period				
Feeding regime	2	2	2	2
No. days	82	82	82	109
Gain per head	190	222	216	239
Gain per day	2.32	2.71	2.63	2.19
Final				
Date	11-5-59	11-5-59	11-5-59	11-10-59
Age	604	658	639	626
Weight	948	1052	1110	964
Score				
Conformation	10.8	10.2	11.2	
Condition				10.4
Gain per day of age	1.47	1.48	1.62	1.54

[1] Group fed an average of 5 lb. corn and cob meal, 1 lb. CSM, 4-5 lb. mixed legume grass hay and a full feed of grass silage.

[2] Implanted with 24 mg. stilbestrol and full feed a mixed feed consisting mostly of ground ear corn while still on pasture.

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958[1]

Location	Crossville	Crossville	Crossville	Crossville
Line or group	5435	5345	5284	5063
Breed of sire	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus
Sex	Steers	Steers	Steers	Steers
Number	3	3	3	5
Initial				
Date	10-1-58	10-1-58	10-1-58	10-30-58
Age (days)	217	204	211	282
Weight (lbs.)	495	480	505	546
Score				
Conformation	11.8	11.8	11.2	10.8
Condition	9.3	9.7	8.5	9.7
First period				
Feeding regime	1	1	1	1
No. days	208	208	208	179
Gain per head	156	160	166	95
Gain per day	0.75	0.77	0.80	0.53
Second period				
Feeding regime	Pasture	Pasture	Pasture	Pasture
No. days	88	88	88	88
Gain per head	63	82	64	11.3
Gain per day	0.72	0.93	0.73	1.28
Third period	2	2	2	2
Feeding regime	109	109	109	109
No. days	228	255	240	279
Gain per day	2.09	2.34	2.20	2.56
Final				
Date	11-10-59	11-10-59	11-10-59	11-10-59
Age	622	609	616	658
Weight	941	977	978	1033
Score				
Condition	10.8	10.3	9.3	10.2
Gain per day of age	1.51	1.60	1.59	1.57

[1]Included with 50 other steers in a comparison of corn silage and hay each with and without terramycin. The above sire groups were represented on each of the treatments as far as possible. All steers received an av. of 3.25 lb. corn, cob, and shuck meal, and 1 lb. of CSM per day. The steers fed silage consumed about 21 lb. silage and 2 lb. hay. The others consumed approximately 9.5 lb. hay per day. The steers on hay gained about .2 lb. per day less than those on silage.

[2]Included with 21 other steers in an experiment involving 3 levels of Prozyme and a control. All Implanted with 36 mg. of Stilbestrol. The av. daily consumption was about 18 lb. ground ear corn, 3 3/4 lb. hay, and 1 3/4 lb. soybean meal. No appreciable difference was observed in the gains on the various levels of Prozyme.

DATA ON ANIMALS SLAUGHTERED

Tennessee Station

Location	Alcoa	Alcoa	Alcoa	Alcoa
Herd	9046	9505	4033	9075
Breed of sire	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford
Sex	Steers	Steers	Steers	Steers
No. slaughtered	12	1	2	11
Age at slaughter	626	572	662	624
Slaughter weight(1)	1045	945	1062	1107
Carcass weight(2)	614	556	629	656
Dressing percentage(3)	58.8	58.8	59.2	59.3
Slaughter grade	10.6	12.0	11.0	11.1
Carcass grade	9.5	9.0	10.8	9.0
Fat thickness over rib eye (ins.)	0.60	0.55	0.61	0.45
Rib eye area (sq. in.)	10.9	11.0	10.6	11.7
W-B Shear(4)				
Core size	1-inch	1-inch	1-inch	1-inch
Shear Force (lbs.)	13.6	13.3	13.8	12.1
9-10-11 Rib Section				
Weight in lbs.	11.0	9.8	10.8	11.5
% Fat	34.3	29.6	36.4	31.8
% Lean	50.7	54.1	48.0	51.8
% Bone	15.0	16.3	15,8	16.4
Marbling Score	3.6	2.0		3.0(8)
Specific Gravity (9-10-11 Rib eye)	1.0637	1.0668	1.0630	1.0610
6-7-8 Rib Section				
Shear (Lbs., 1 in. core)	15.3(11)	16.0	14.6	15.3(10)
Panel Score(6)				
Flavor	7.4(11)	7.2	7.3	7.3
Juiciness	7.1(11)	6.4	7.5	7.2
Tenderness	7.1(11)	8.4	7.9	6.9

(1) Steers slaughtered 24 hours after slaughter weight was taken.
(2) Hot carcass weight less 2 1/2 % shrink.
(3) Chilled carcass weight x 100 / slaughter weight.
(4) 12th rib.
(5) Possible scores range from 1 for devoid of marbling to 12 for extremely abundant marbling.
(6) Possible scores range from 1 to 9 for each item with a score of 9 indicating most flavor, juiciness, or tenderness.
(7) Figures in ()'s after the values indicate the number of animals represented where observations were not obtained on all animals in the group.

DATA ON ANIMALS SLAUGHTERED

Tennessee Station

Location	Alcoa	Alcoa	Alcoa	Alcoa
Herd	9416	9023	9217	9120
Breed of sire	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford
Sex	Steers	Steers	Steers	Steers
No. slaughtered	2	11	5	8
Age at slaughter	568	633	636	609
Slaughter weight(1)	1030	1039	1014	951
Carcass weight(2)	596	597	601	556
Dressing percentage(3)	57.9	57.5	59.3	58.5
Slaughter grade	11.2	10.8	11.2	10.8
Carcass grade	9.2	9.0	9.6	9.2
Fat thickness over rib eye (ins.)	0.57	0.48	0.53	0.59
Rib eye area (sq. in.)	11.1	10.7	11.9	10.6
W-B Shear(4)				
Core size	1-inch	1-inch	1-inch	1-inch
Shear Force (lbs.)	17.8	12.4	14.4	13.6(7)
9-10-11 Rib Section				
Weight in lbs.	10.1	10.3	10.8	10.0
% Fat	31.2	30.8	31.5	33.0
% Lean	53.0	53.0	53.6	51.5
% Bone	15.8	17.0	15.0	15.5
Marbling Score(5)	3.5	3.3(10)	4.2	3.8
Specific Gravity (9-10-11 Rib eye)	1.0662	1.0654	1.0640	1.0633
6-7-8 Rib Section				
Shear (lbs. 1-inch core)	13.2	14.4(9)	13.4	16.7
Panel Score(6)				
Flavor	7.1	7.4(9)	7.4	7.4
Juiciness	6.9	7.1(9)	7.1	7.0
Tenderness	6.9	7.5(9)	7.5	6.9

(1) Steers slaughtered 24 hours after slaughter weight taken.
(2) Hot carcass weight less 2 1/2% shrink.
(3) Chilled carcass weight x 100/slaughter weight.
(4) 12th rib.
(5) Possible scores range from 1 for devoid of marbling to 12 for extremely abundant marbling.
(6) Possible scores range from 1 to 9 for each item with a score of 9 indicating most flavor, juiciness or tenderness.
(7) Figures in ()'s after the values indicate the number of animals represented where observations were not obtained on all animals in the group.

DATA ON ANIMALS SLAUGHTERED

Tennessee Station

Location	Alcoa	Alcoa	Crossville	Crossville
Herd	9000	9611	5244	5435
Breed of sire	Hereford	Hereford	Angus	Angus
Breed of dam	Hereford	Hereford	Angus	Angus
Sex	Steers	Steers	Steers	Steers
No. slaughtered	2	5	5	3
Age at slaughter	663	643	634	630
Time in feedlot (days)			405	405
Gain in feedlot (lbs.)			476	447
Final feedlot weight			964	941
Slaughter weight(1)	1065	1116		
Carcass weight(2)	614	666	538	542
Dressing percentage(3)	57.7	59.7		
Slaughter grade	10.2	11.2	10.4	10.8
Carcass grade	9.8	9.8	11.2	11.3
Fat thickness over rib eye (ins.)	0.53	0.40	0.24	0.37
Rib eye area (sq. in.)	10.4	12.1	12.92	11.64
W-B Shear(4)				
Core size	1-inch	1-inch	1-inch	1-inch
Shear Force (lbs.)	16.6	15.1	16.7	16.3
9-10-11 Rib Section				
Weight in lbs.	10.8	11.7	10.7	10.4
% Fat	32.6	33.9	29.9	36.0
% Lean	51.8	50.4	55.8	49.3
% Bone	15.4	15.7	14.4	14.8
Marbling Score(5)	3.0	4.0	6.6	5.7
Specific Gravity (9-10-11 Rib eye)	1.0654	1.0647	1.0630	1.0640
6-7-8th Rib Section				
Shear (lbs., 1-inch core)	12.8	16.4	19.3	19.9
Panel Score(6)				
Flavor	7.5	7.6	7.4	7.3
Juiciness	6.9	7.2	7.4	6.9
Tenderness	7.2	7.0	6.4	5.9

(1) Steers were held eight days after final feedlot weights were taken before they were slaughtered. Individual slaughter weights not taken.
(2) Hot carcass weight less 2 1/2 % shrink.
(3) Did not calculate
(4) 12th Rib
(5) Possible scores range from 1 for devoid of marbling to 12 for extremely abundant marbling.
(6) Possible scores for each item range from 1 to 9 with a score of 9 indicating most flavor, juiciness and tenderness.

DATA ON ANIMALS SLAUGHTERED

Tennessee Station

Location	Crossville	Crossville	Crossville
Herd	5345	5284	5063
Breed of sire	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus
Sex	Steers	Steers	Steers
No. slaughtered	3	3	5
Age at slaughter	617	624	666
Time in feedlot (days)	405	405	376
Gain in feedlot (lbs.)	497	470	487
Final feedlot weight	977	978	1033
Carcass weight[(1)]	550	554	588
Slaughter grade	10.3	9.3	10.2
Carcass grade	10.3	10.0	11.0
Fat thickness over rib eye (ins.)	0.38	0.28	0.41
Rib eye area (sq. in.)	11.14	12.75	11.91
W-B Shear			
Core size	1-inch	1-inch	1-inch
Shear Force (lbs.)	14.5	17.1	14.0
9-10-11 Rib Section			
Weight in lbs.	10.1	10.5	11.0
% Fat	28.8	26.2	36.5
% Lean	55.7	58.6	49.6
% Bone	15.6	15.8	13.8
Marbling Score[(2)]	5.3	4.3	5.4
Specific Gravity (9-10-11 Rib eye)	1.0656	1.0626	1.0624
6-7-8th Rib Section			
Shear (lbs., 1-inch core)	16.5	18.7	16.8
Panel Score[(3)]			
Flavor	7.2	7.1	7.3
Juiciness	6.9	7.3	7.2
Tenderness	7.3	6.9	6.7

(1) Hot carcass weight less 2 1/2 % shrink.

(2) Possible scores range from 1 for devoid of marbling to 12 for extremely abundant marbling.

(3) Possible scores range from 1 to 9 for each item with a score of 9 indicating most flavor, juiciness or tenderness.

Texas Station

by

T. C. Cartwright

I. PROJECT: Anim. Husb. 650. (S-10)(AHRD d1-22)

The Improvement of Production and Desirability of Beef Through Breeding Methods.

II. OBJECTIVES:

A. To estimate and further test by selection and breeding, genetic parameters including heritability, heterotic effect and genetic correlations for:

1. Weaning weight.
2. Post-weaning feedlot and pasture gain.
3. Gain during the summer months.
4. Beef value of the carcass including distribution of carcass weight among various cuts and muscle, fat and bone.
5. Eating desirability of the beef.
6. Other characters as their possible importance becomes evident.

B. To test breeds and strains of unknown or unrecorded productivity.

C. To develop procedures and techniques adequate for practical application in:

1. Record keeping.
2. Artificial insemination.
3. Other areas involved in management that present an obvious need in a breeding program.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Approximately 200 grade Hereford cows and adequate pasturage and handling facilities have been added to the project. The cattle are located in the Brazos River bottoms about 8 miles from College Station. Equipment for collecting, freezing and storing semen have been added for partial use of this project.

B. Weights and gains taken from 2420 gain test cattle over a 7-year period indicated that periodic (28-day) gains tended to be cyclic or compensatory (negative repeatabilities of -.13 to -.03) whereas weights taken on consecutive days were highly repeatable (.98) suggesting that the two weights averaged to obtain initial and final weights should be separated by more than one day. Variances associated with bulls were larger than those with heifers but coefficients of variation were smaller indicating little justification for shortening tests for heifers because of accuracy. There

was a slight decrease in accuracy incurred by overnight shrinking vs. no shrink before weighing, suggesting that the period was excessive in length (14 hrs.) for cattle expected to produce subsequently.

C. The usefulness of hair coat characteristics as indicators of tenderness of beef was explored. Hair samples from definite areas were counted and measured and the value correlated with shear force of 51 steers. Hair density was positively correlated (.25) with av. shear force but not of such a magnitude as to suggest utility as a correlated character in a selection program.

D. A least squares analysis of weaning weights from 1737 calves showed that the state of parity of a cow the previous year had almost no effect on the weaning weight of her calf. Differences due to sex, year and age of dam were of the magnitude expected. Differences in inherent capacities of breeds were found which ranged upward from an arbitrary standard, the Hereford, to 125 lbs. advantage for the Charbray. Various crosses of the Brahman and Hereford showed that (1) a hybrid calf had some advantage, (2) a hybrid dam had an additional advantage and (3) the maximum weights from these breeds were obtained from systems that tended to maintain maximum hybridity primarily in the dam and secondarily in the calf.

E. Data from 195 steers slaughtered over a 5-year period were analyzed to estimate heritability and the inter-relationship among gain on 140-day test (heritability = .58), chilled carcass weight per day (h= .11), sq. in. rib-eye per cwt. (h = .73, USDA grade (h = .15), per cent ether extract (h = .64) and lbs. shear force (h = .59). Tenderness, as measured by shear force, tended to increase with rate of gain immediately preceding slaughter. Some other relationships were perplexing and no explanation was obvious. Further analysis of these data is indicated.

IV. FUTURE PLANS:

To continue work as outlined in the project statement. Two genetic control herds will be established - one at McGregor and one at College Station.

V. PUBLICATIONS DURING THE YEAR:

Cartwright, T. C., 1959. Phenotypic correlations between diameter and density of hair and tenderness of beef. J. An. Sci. 18:1476 (abstract).

Cartwright, T. C. and E. E. Dayhoff. 1959. Some factors influencing variation in 28-day gains of feed-lot cattle. J. An. Sci. 18: 1463 (abstract).

VI. PUBLICATIONS PLANNED:

Technical articles reporting the results of least squares analyses of weaning weights, yearling weights, and carcass and meats data are planned.

PERFORMANCE OF COW HERDS. 1959 CALVES

Texas Agricultural Experiment Station
Substation 23, McGregor, Texas

Location	McGregor, Texas					
Breed of sire	Angus	Brahman	Charolais	Hereford	St. Gert.	Brahman
Breed of dam	Angus	Brahman	Charbray	Hereford	St. Gert.	Hereford
No. cows calving	9	20	18	74	10	19
No. calves raised	9	16	16	62	8	18
Av. birth date	1-14-59	3-1-59	3-15-59	2-15-59	4-1-59	2-13-59
Av. birth wt. (lbs.)	56	63	83	72	69	87
Av. weaning age	180	180	180	180	180	180
Av. weaning wt.	366	384	504	393	404	449
Were calves creep fed?	No	No	No	No	No	No
Av. daily gain from birth to weaning	2.0	2210	2.8	2.2	2.2	2.5

PERFORMANCE OF COW HERDS. 1959 CALVES

Texas Agricultural Experiment Station
Substation 23, McGregor, Texas

Location	McGregor, Texas					
Breed of sire Breed of dam	Brahman 1 Cross	Brahman 4 Cross	Hereford Brahman	Hereford 1 Cross	Hereford 4 and 23 Cross	Charolais 1 Cross
No. cows calving No. calves raised	27 23	21 17	14 14	22 21	7 7	9 8
Av. birth date Av. birth wt. (lbs.)	2-8-59 70	3-5-59 70	2-7-59 64	2-4-59 64	3-29-59 60	2-25-59 81
Av. weaning age Av. weaning wt.	180 434	180 416	180 444	180 459	180 382	180 542
Were calves creep fed?	No	No	No	No	No	No
Av. daily gain from birth to weaning	2.4	2.3	2.5	2.6	2.1	3.0

PERFORMANCE OF COW HERDS. 1959 CALVES

Texas Agricultural Experiment Station
Substation 23, McGregor, Texas

Location Breed of sire Breed of dam	McGregor, Texas Charolais 8 and 9 Cross	 Charolais 15 Cross	 St. Gert. Hereford	 St. Gert. Red Poll	 St. Gert. 1 Cross	 St. Gert. 11 Cross
No. cows calving No. calves raised	10 10	1 1	5 5	11 9	8 5	20 19
Av. birth date Av. birth wt. (lbs.)	2-13-59 87	4-30-59 84	2-19-59 78	3-3-59 83	2-18-59 74	2-19-59 73
Av. weaning age Av. weaning wt.	180 485	180 387	180 404	180 474	180 477	180 453
Were calves creep fed?	No	No	No	No	No	No
Av. daily gain from birth to weaning	2.7	2.2	2.2	2.6	2.7	2.5

PERFORMANCE OF COW HERDS. 1959 CALVES

Texas Agricultural Experiment Station
Substation 23, McGregor, Texas

Location	McGregor, Texas					
Breed of sire Breed of dam	St. Gert. 32 Cross	St. Gert. 13Cross	St. Gert. 42 Cross	St. Gert. 51 Cross	St. Gert. 14 Cross	St. Gert. 61 Cross
No. cows calving No. calves raised	1 1	7 4	1 1	1 1	3 2	2 2
Av. birth date Av. birth wt. (lbs.)	2-8-59 84	3-12-59 74	5-8-59 80	1-16-59 68	1-24-59 76	2-24-59 90
Av. weaning age Av. weaning wt.	180 502	180 450	180 441	180	180 497	180 541
Were calves creep fed?	No	No	No	No	No	No
Av. daily gain from birth to weaning	2.8	2.5	2.5		2.8	3.0

DATA ON ANIMALS SLAUGHTERED

Texas Agricultural Experiment Station

Location	McGregor, Texas							
Herd	Regular							
Breed of sire	Hereford	Brahman	1X Cross	Angus	St. Gert.	(5) Brown Swiss	Brahman	Hereford
Breed of dam	Hereford	Brahman	Brahman	Angus	St. Gert.	Brown Swiss	Hereford	Brahman
Sex	Bulls	Bulls	Bull	Steers	Steers	Steers	Steers	Steers
No. slaughtered	2	4	1	2	5	2 (5)	2	1
Age at slaughter	443	405	475	424	464	453 (456)	391	457
Time in feedlot	140	140	140	140	140	140 (140)	140	140
Gain in feedlot (lbs.)	362	275	327	304	252	334 (393)	323	342
Final feedlot weight	884	843	1144	889	1001	905 (853)	948	972
Slaughter weight(1)	937	804	895	915	1007	932 (836)	937	925
Carcass weight(2)	529	470	526	575	586	544 (477)	580	550
Dressing percentage(3)	56.04	58.50	58.77	62.81	58.25	58.34 (57.13)	61.92	59.46
Carcass grade	Std. 14	CM-10	CM-10	CH-19	G-15	ST+15 (ST+15)	G-17	G-16
Fat thickness over rib eye (ins.)	.24	.16	.27	.90	.41	.29 (.41)	.46	1.59
Rib eye area (sq. in.)	10.23	9.05	8.50	8.78	8.79	9.78 (8.76)	8.48	8.10
W-B shear								
Shear force (lbs.)	14.97	16.30	16.13	9.56	10.85	9.90 (12.94)	9.60	10.31
9-10-11 Rib section								
Weight in lbs.								
% Fat	3.53	6.17	7.34	12.60	8.85	6.52 (5.06)	11.40	10.10
% Lean	9.94	9.70	8.63	8.36	9.21	9.75 (9.57)	9.29	8.25
% Bone	4.71	5.58	5.68	3.92	5.43	5.54 (5.54)	4.24	4.54

(1) 18 hours elapsed between removal from feedlot and slaughter.
(2) Chilled carcass weight.
(3) Dressing percentage based on slaughter weight and chilled carcass weight.
(4) Core size 1/2".
(5) Steers in ( ) on oat grazing 140 days.

DATA ON ANIMALS SLAUGHTERED

Texas Agricultural Experiment Station

Location	McGregor, Texas							
Herd	Regular							
Breed of sire	Brahman	Hereford	1 Cross	1 Cross	St. Gert.	Charolais	Charolais	1 Cross
Breed of dam	1 Cross	3 Cross	Brahman	Hereford	1 Cross	Hereford	1 Cross	1 Cross
Sex	Steers	Steers	Steers	Steers	Steers	Steers	Steers	Steers
No. slaughtered	6	3	5	7	2	2	2	6
Age at slaughter	464	388	422	391	407	398	387	387
Time in feedlot (days)	140	140	140	140	140	140	140	140
Gain in feedlot (lbs.)	285	336	329	324	254	275	327	299
Final feedlot weight	895	919	872	919	912	912	965	893
Slaughter weight(1)	880	892	859	931	875	937	974	876
Carcass weight(2)	534	532	691	558	499	562	584	529
Dressing percentage(3)	60.72	59.64	60.60	60.02	57.00	59.95	59.98	60.42
Carcass grade	15	ST+15	ST-14	ST 13	ST+15	C-16	ST+15	ST 14
Fat thickness over rib eye (ins.)	.55	.47	.69	.45	.68	.30	.40	.43
Rib eye area (sq. in.)	8.73	8.81	8.38	9.07	8.85	10.03	9.79	8.49
W-B shear Shear force (lbs.)	15.18	7.61	11.35	12.49	10.66	13.38	15.47	12.88
9-10-11 Rib section Weight in lbs.								
% Fat	8.97	8.07	7.78	8.50	6.73	5.57	7.72	9.20
% Lean	9.27	9.16	9.08	9.24	9.99	9.81	9.1	8.99
% Bone	4.97	4.80	4.97	4.86	5.43	5.20	5.23	4.72

DATA ON ANIMALS SLAUGHTERED

Texas Agricultural Experiment Station

Location	McGregor, Texas					
Herd	Regular					
Breed of Sire	Brahman	St. Gert.	St. Gert.	Hereford	1 Cross	Brahman
Breed of Dam	4 Cross	11 Cross	Red Poll	1 Cross	1 Cross	4 Cross
Sex	Steers	Steers	Steers	Heifers	Heifers	Heifers
No. Slaughtered	4	2	2	1	6	2
Age at slaughter	459	460	417	452	420	408
Time in feedlot (days)	140	140	140	140	140	140
Gain in feedlot (lbs.)	292	439	393	271	272	224
Final feedlot weight	901	1119	1058	856	847	687
Slaughter weight(1)	888	1063	990	823	838	676
Carcass weight(2)	553	631	790	503	493	404
Dressing percentage(3)	62.29	59.36	60.60	61.12	58.75	59.69
Carcass grade	14	15	16	14	14	16
Fat thickness over rib eye (ins.)	1.04	1.79	.75	.58	.61	.51
Rib eye area (sq.in.)	8.56	9.64	9.81	9.04	8.71	7.36
W-B Shear						
Shear Force (lbs.)	10.80	11.28	9.07	18.25	14.38	17.00
9-10-11 Rib Section						
Weight in lbs.						
% Fat	9.31	11.31	10.34	12.11	11.16	10.68
% Lean	8.93	7.94	8.93	8.68	9.04	9.18
% Bone	4.49	4.53	4.66	4.51	4.94	4.65

DATA ON ANIMALS SLAUGHTERED

Texas Agricultural Experiment Station

Location	McGregor, Texas					
Herd	Regular					
Breed of Sire	St. Gert.	Hereford	Brahman	Brahman	1 Cross	1 Cross
Breed of Dam	11 Cross	Hereford	Hereford	1 Cross	Brahman	Hereford
Sex	Heifers	Heifers	Heifers	Heifers	Heifers	Heifers
No. slaughtered	2	4	3	4	6	1
Age at slaughter	386	388	400	420	412	401
Time in feedlot (days)	140	140	140	140	140	140
Gain in feedlot (lbs.)	205	198	251	211	234	263
Final feedlot weight	745	632	735	728	739	869
Slaughter weight(1)	792	697	739	726	739	905
Carcass weight(2)	476	398	454	456	442	542
Dressing percentage(3)	60.17	57.15	61.36	62.70	59.59	59.89
Carcass grade	G 17	ST + 15	16	16	15	13
Fat thickness over rib eye (ins.)	.80	.48	.69	.65	.42	.52
Rib eye area (sq.in.)	8.52	7.37	8.02	8.67	8.17	9.74
W-B Shear						
Shear Force (lbs.)	12.91	10.74	13.00	16.99	14.95	18.81
9-10-11 Rib Section						
Weight in lbs.						
% Fat	15.19	10.38	12.54	10.76	11.17	12.57
% Lean	8.55	9.35	8.42	8.84	9.08	8.21
% Bone	4.13	4.66	4.62	5.13	4.77	4.77

I. PROJECT: Anim. Husb. 607. (S-10)(AHRD d1-22)

Improvement of Beef Cattle Through Selection of Performance Tested and Progeny Tested Sires.

II. OBJECTIVES:

A. To determine the heritability of gain and other economic characteristics as beef conformation, quality of flesh, earliness of maturity, and size of animal.

B. To study the effects of the application of such information on the improvement of breeding herds.

C. To determine the mode of inheritance of the pigmentation of eye lids and to determine the relationship of eye lid pigmentation to "cancer eye."

D. To make detailed analysis of appropriate existing data.

E. To determine suitable and economical rations of locally grown feeds and supplements for proper development of young breeding stock.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Balmorhea (A. A. Melton)

1. No new facilities.

2. There were 38 bulls and 14 steers entered in the test this past year. Of the 38 bulls all were Hereford, except three Angus, and all of the steers were Hereford. The average daily gain on the bulls was 2.63 lb. daily. The steers are half brothers to the bulls, and are still on feed at present. They will be slaughtered later and carcass evaluations made.

B. McGregor (W. E. Kruse)

1. No new facilities.

2. Two separate tests were conducted. In the first test there were 284 cattle of which 123 were entered by cooperators. There were 195 cattle on the second test with 84 entered by cooperators. Average daily gains were: bulls, 2.3, 2.5; heifers 1.7, 2.0; and steers 2.2, 2.5 for the first and second tests respectively for the cattle in the feed lot. Forty heifers and 28 steers were tested on oat pasture as part of the second test. On pasture the average daily gain for steers was 2.1 and for heifers 1.8.

C. Pan Tech (George F. Ellis, Jr.)

1. Supplemental project objectives at this station are:

a. To compare the gaining ability of bulls from different sources when they are fed the same ration under uniform conditions.

b. To determine the relationships that exist among the following characteristics.

(1) Gain on 140 day feed test
(2) Weaning weight adjusted to 205 days of age
(3) Actual weaning weight
(4) Gain from weaning to start of test
(5) Initial test weight
(6) Age at start of test
(7) Efficiency of feed utilization during 140 day feed test.

c. To develop a method of evaluating and selecting superior sires, based on the information given above.

2. Accomplishments during the year:

a. No new facilities.

b. One hundred thirty eight bulls were tested, including 126 Herefords, 8 Angus, and 4 Charbrays. Average daily gain was 2.42 lbs. per day.
Ten steers, half brothers to the bulls, are now on feed and will be slaughtered to obtain carcass information.

IV. FUTURE PLANS:

All stations plan to continue existing work.

V. PUBLICATIONS DURING THE YEAR:

Melton, A. A. Monthly test reports and field day report, February 27, 1960.

Kruse, W. E. Beef cattle gain evaluation test reports. Texas Agr. Exp. Sta. Mirc. Reports 305 and 327.

Smith, J. P., and George F. Ellis, Jr. Monthly test reports, and field day report. March 24, 1960.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Balmorhea, Texas

Location	Balmorhea, Texas----------	
Breed of dam	Hereford	Angus
BULLS, No.	35	3
Av. initial wt. (lbs.)	615	602
Av. no. days on feed	140	140
Av. final weight	983	
Av. daily gain	2.63	
Av. score		
Conformation(1)	6.4-7.0	6.5-7.0
Condition(2)	6.0	5.9
Av. feed per day(3)		
Concentrates	11 lb.	10.9 lb.
Roughage	11 lb.	10.9 lb.
STEERS, No.	10	
Av. initial age (days)	237	
Av. initial wt. (lbs.)	463	
Av. no. days on feed	220	
Av. score		
Conformation	6.1	

(1)First figures initial and second - final.
(2)Initial only
(3)Feed ground, mixed and self feed.

DATA ON ANIMALS SLAUGHTERED

Location	Marfa	Sanderson	Ft. Stockton
No. slaughtered	4	2	4
Age at slaughter	15 1/2 mos.	15 1/2 mos.	15 1/2 mos.
Time in feedlot(days)	220	220	220
Gain in feedlot(lbs.)	1791	804	1987
Final feedlot weight	970	736	991
Slaughter weight(1)	942	720	954
Carcass weight(2)	587	440	593
Dressing percentage(3)	62.32	61.8	62.16
Carcass grade	Choice-	Good +	Good +
Fat thickness over rib eye (ins.)	.92	.45	.84
Rib eye area (sq.in.)	9.75	8.02	9.15
W-B Shear			
Shear Force (lbs.)	8.64	5.63	8.66

(1)Taken off feed and water, night of 5/15/59, trucked 500 miles to College Station, 5/16/59, had hay and water until slaughtered 5/18/59.
(2)Cold.
(3)Live slaughter wt. and cold carcass.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Texas Agricultural Experiment Station

Location	McGregor, Texas					
Breed of sire Breed of dam	Hereford Hereford	St. Gert. St. Gert.	Brahman Brahman	Charolais Charbray	Angus Angus	Shorthorn Shorthorn
	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.
BULLS, No.	9 63	66	10	3 4	1 4	5
Av. initial age(days)	298	300	270	271	301	333
Av. initial wt.(lbs.)	630	702	533	736	575	625
Av. no. days on feed	140	140	140	140	140	140
Av. final weight	946	1065	817	1126	893	974
Av. daily gain	2.3	2.6	2.0	2.8	2.3	2.5
Av. score Condition	58	57	50	58	61	59
STEERS, No.	6(4)	5			3	
Av. initial age(days)	243(324)	324			314	
Av. initial wt.(lbs.)	545(537)	749			595	
Av. no. days on feed	140	140			140	
Av. final weight	880(899)	1001			897	
Av. daily gain	2.4(2.6)	1.8			2.1	
Av. score Condition	72(53)	69			73	
HEIFERS, No.	16(7) 17	46	6(1)	9(3) 12	4	
Av. initial age(days)	278(310)	281	249(259)	286(303)	284	305
Av. initial wt.(lbs.)	478(497)	598	453(380)	601(637)	434	461
Av. no. days on feed	140	140	140	140	140	140
Av. final weight	700(748)	863	674(601)	890(908)	659	708
Av. daily gain	1.6(1.8)	1.9	1.6(1.6)	2.1(2.0)	1.6	1.8
Av. score Condition	59(50)	62	59(37)	61(48)	67	60

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Texas Agricultural Experiment Station

Location	McGregor, Texas											
Breed of sire	Brangus		Red Brangus		Hereford		Brahman		Hereford		1 Cross	
Breed of dam	Brangus		Red Brangus		Brahman		1 Cross		1 Cross		Hereford	
	BF	Coop.	BF	Coop.	BF	Coop.	BF	Coop.	BF	Coop.	BF	Coop.
BULLS, No.		1		1	1		2					
Av. initial age (days)	358		317		241		287					
Av. initial wt. (lbs.)	802		597		728		697					
Av. no. days on feed	140		140		140		140					
Av. final weight	1145		959		1081		1081					
Av. daily gain	2.5		2.6		2.5		2.7					
Av. score												
Condition	53		53		60		62					
STEERS, No.					2(2)		8		4(3)		8(2)	
Av. initial age(days)					277(327)		276		287(320)		279(313)	
Av. initial wt.(lbs.)					617(697)		610		660(679)		636(588)	
Av. no. days on feed					140		140		140		140	
Av. final weight					888(1006)		895		935(977)		1082(996)	
Av. daily gain					1.9(2.2)		2.0		2.0(2.2)		3.2(3.0)	
Av. score												
Conformation					60(65)		66		58(55)		72(60)	
HEIFERS, No.					2(3)		7		7(1)		1	
Av. initial age (days)					229(309)		280		282(306)		261	
Av. initial wt. (lbs.)					564(597)		518		548(503)		606	
Av. no. days on feed					140		140		140		140	
Av. final weight					814(864)		728		820(760)		869	
Av. daily gain					1.8(1.9)		1.5		1.9(1.8)		1.9	
Av. score												
Condition					69(58)		59		62(57)		67	

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Texas Agricultural Experiment Station

Location	McGregor, Texas					
Breed of sire	St. Gert.	St. Gert.	Brown Swiss	Charolais	St. Gert.	St. Gert.
Breed of dam	Hereford	11 Cross	Brown Swiss	Hereford	32 Cross	51 Cross
	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.
STEERS, No.		4(1)	(5)2	2		
Av. initial age (days)		280(321)	313(295)	258		
Av. initial wt. (lbs.)		673(611)	571(459)	637		
Av. no. days on feed		140	140	140		
Av. final weight		1051(984)	905(852)	912		
Av. daily gain		2.7(2.7)	2.4(2.8)	2.0		
Av. score Condition		76(63)	53(47)	75		
HEIFERS, No.	2(2)	6(2)		(1)	(1)	(1)
Av. initial age (days)	255(299)	245(290)		(304)	(318)	(267)
Av. initial wt. (lbs.)	586(565)	521(483)		(594)	(636)	(486)
Av. no. days on feed	140	140		(140)	(140)	(140)
Av. final weight	855(948)	747(737)		(827)	(915)	(766)
Av. daily gain	2.0(2.8)	1.6(1.8)		(1.7)	(2.0)	(2.0)
Av. score Condition	75(57)	67(57)		(63)	(67)	(47)

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Texas Agricultural Experiment Station

Location	McGregor, Texas					
Breed of sire / Breed of dam	St. Gert. 13 Cross	St. Gert. Red Poll	St. Gert. 14 Cross	St. Gert. 1 Cross	Charolais 1 Cross	Hereford Brahman
	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.	BF Coop.
STEERS, No.	(3)	2(1)		2(2)	2	
Av. initial age (days)	(291)	277(237)		267(315)	247	
Av. initial wt. (lbs.)	(618)	665(621)		658(662)	638	
Av. no. days on feed	140	140		140	140	
Av. final weight	(993)	1058(1020)		912(1007)	965	
Av. daily gain	(2.7)	2.8(2.9)		1.8(2.5)	2.4	
Av. score Condition	(61)	70(63)		70(67)	74	
HEIFERS, No.	(1)	3(6)	3	4(2)	2(2)	3
Av. initial age (days)	(333)	240(306)	248	231(300)	240(305)	253
Av. initial wt. (lbs.)	(612)	561(598)	603	515(604)	568(565)	525
Av. no. days on feed	(140)	140	140	140	140	140
Av. final weight	(907)	786(837)	847	753(865)	801(823)	754
Av. daily gain	(2.1)	1.6(1.7)	1.7	1.7(1.9)	1.7(1.8)	1.6
Av. score Condition	(67)	65(60)	68	69(60)	62(55)	64

FOOTNOTES: Postweaning Performance of 1958 Calf Crop

(1) Ration: 20% Ground grain sorghum
15% Cottonseed meal
65% Ground Hay (1/2 Oats and Clover, 1/2 Sudan)

Average feed per day:

Bulls	23.1 lbs.
Heifers	18.0 lbs.
Steers	20.3 lbs.

Feed, water, salt and bone meal were before the cattle at all times, free choice. 140-day feeding period.

(2) Cattle data in ( ) were on oat grazing for a period of 140 days.

(3) Condition Score: (average of 3 judges).

10 thin-	40 medium -	70 fat-
20 thin	50 medium	80 fat
30 thin +	60 medium +	90 fat +

PERFORMANCE OF COW HERDS. 1959 CALVES

PanTech Farms, Texas

Location	PanTech Farms, Panhandle, Texas----------------------			
Line or group	A	B	C	F
Breed of sire	Hereford	Hereford	Hereford	Hereford
No. cows calving	25	26	26	23
No. calves raised	21	24	22	19
Av. birth date	3-6-59	3-1-59	3-7-59	3-7-59
Av. weaning age	228	221	216	214
Av. weaning wt.	481	504	513	475
Av. weaning type score*	7.0	7.4	7.6	6.5
Were calves creep fed?	No			
Weaning weight adjusted to 205 days of Age	458	473	491	458

* Fancy	9
Fancy minus	8
Choice	7
Choice minus	6
Good	5
Good minus	4

POSTWEANING PERFORMANCE OF 1958 CALVES FULL-FED AFTER WEANING
(or pastured for high gains)

Location	PanTech Farms, Texas--			
Line or group	A	B	C	D
Breed of sire	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford
STEERS, No.	9	12	9	12
Av. initial age (days)	365	364	365	365
Av. initial wt. (lbs.)	658	687	701	608
Av. no. days on feed	147	147	147	147
Av. final weight	1047	1073	1081	972
Av. daily gain	2.65	2.63	2.59	2.48
Av. feed per day				
Concentrates	16 lbs.--->			
Roughage	40 lbs. silage-------------------------------->			

PERFORMANCE DATA ON YEARLING OR OLDER CATTLE NOT IN BREEDING HERDS IN 1958(1)

Location	-----Pan Tech Farms, Texas--------		
Breed of sire	Hereford	Angus	Charbray
Breed of dam	Hereford	Angus	Charbray
Sex	Bulls	Bulls	Bulls
Number	126	8	4
Initial			
Date	10/27/59	10/27/59	10/27/59
Age (days)	327	323	278
Weight (lbs.)	699	685	685
First period			
Feeding regime	60% roughage------------------------ 40% concentrates------------------		
No. days	140	140	140
Gain per head	339	343	326
Gain per day	2.42	2.45	2.33
Final			
Date	3/15/60	3/15/60	3/15/60
Age	467	463	418
Weight	1038	1027	1011
Score*			
Conformation	11.6	12.1	9.8
Gain per day of age**	2.07	2.07	2.25

*Fancy plus	17	Choice plus	14	Good plus	11
Fancy	16	Choice	13	Good	10
Fancy minus	15	Choice minus	12	Good minus	9

**Assuming 70 lb. birth wt.

DATA ON ANIMALS SLAUGHTERED

Herd	A	B	C	D
Breed of sire	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford
Sex	Steers	Steers	Steers	Steers
No. slaughtered	9	12	9	12
Age at slaughter	512	511	512	512
Time in feedlot (days)	147	147	147	147
Gain in feedlot (lbs.)	2.65	2.63	2.59	2.48
Final feedlot weight	1047	1073	1081	972
Slaughter weight	1047	1073	1081	972
Carcass weight*	580	587	605	544
Dressing percentage	58.31	57.59	58.91	58.91
Carcass grade	Low choice	Low choice	High good	Low choice
Av. Carcass Value	$251.64	$254.00	$258.91	$234.54

*Hot weight less 3%.

Tex (21)

Texas Station

-by-

H. O. Kunkel

I. PROJECT: 714(S-10)

Methods for Measuring Potential Rate of Gain and Efficiency of Feed Utilization in Immature Beef Cattle.

II. OBJECTIVES:

A. To develop methods of a biochemical or physiological nature which will measure the potential rate of gain in immature beef animals.

B. To develop methods of measurement of potential efficiency of utilization of feed for building body tissue.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. The research carried out under this project prior to 1959 consisted largely of searches for variations in blood constituents and other biochemical and physiological measurements which may be related to the potential performance of cattle. The results of these searches provided strong evidence that variations in the capacities for growth and conversion of feed into body gains are reflected in quantitative biochemical differences within the animal. The interpretation of the differences discovered and the subsequent development of an index predictive of future growth, however, have been greatly hampered by inadequate basic or fundamental data concerning the biological significances, the physiological controls, and the appropriate bases for measurement of the biochemical investigated.

During the past year greater emphasis was placed upon precursive studies of basic physiological and biochemical changes occurring with growth of animals. The practicability of using experimental animals other than young beef cattle was tested with some measure of success in at least two phases. Studies with feedlot sheep led to the description of ruminal desquamation, a oondition leading to reduction of rates of gain. A similar condition and effect appears to exist in beef cattle. A negative correlation between rate of gain and serum diphenylamine oxidase was observed in sheep and was subsequently noted in a preliminary study of cattle.

B. Ruminal Development.

1. The preliminary observations that the development of the rumen mucosae is reflective of the rate of growth within lambs were confirmed. However, the first evidence was obtained to indicate that drugs, implanted diethylstilbestrol, could disassociate the rate of gain from the extent of ruminal development (table 1). The

variation in ruminal development observed in feed lot lambs not treated with diethylstilbestrol appears to be a structural expression of the growth rate and possibly of the capacity for growth or the capacity to digest and utilize feedstuffs.

2. Evidence was obtained to suggest that maintenance of the integrity of the ruminal epethelial is also essential for maximum rate of growth of a ruminant. Lambs which upon slaughter show signs of mucosal desquamation often have a history of little or no gain during one of the 4-week periods of the feeding trial. Such lambs show a significant decrease in overall feedlot gain (table II). Evidence has been obtained to indicate occurrence of ruminal desquamation and rumenitis in beef steers.

C. Blood Serum Constituents

1. The studies of biochemical changes associated with variable growth were limited to those of serum ceruloplasmin and alkaline phosphatase activities. Preliminary data were obtained which indicate that ceruloplasmin is negatively related to the concurrent rate of gain of wethers, during a warm weather feeding trial. The relationship seemed evident also in the lambs receiving relatively high levels of hexestrol or hydroxyzine. The serum alkaline phosphatase appears related to growth in lambs receiving hexestrol or hydroxyzine but not in the control lambs. Data from a subsequent experiment have been obtained, but analyses of results have not been completed.

2. The present data are indicative, again, of biochemical relationships to growth under certain conditions, but no other inference should be drawn until more extensive experiments are completed. However, in a preliminary experiment with 18 grazing cattle, a coefficient of correlations of -0.49 (p 0.05) was obtained between the concurrent gain and the serum ceruloplasmin level.

IV. FUTURE PLANS:

An extensive review of the physiological bases of genetically variable growth is being prepared. Attempts will be made to determine the physiological phenomena which induce ruminal development and ruminal desquamation and retrogression. The biochemical investigations will be continued. Attempts will be made to determine the genetic relationships involved.

V. PUBLICATIONS DURING THE YEAR:

Deyoe, C. W., and H. O. Kunkel. 1959. Bovine serum ceruloplasmin. J. Anim. Sci. 18:1559 (Abstract).

Kunkel, H. O., F. E. Tutt, J. D. Robbins and J. H. Sinclair. 1959. Relationship of development of ruminal mucosae of lambs to feed consumption and feedlot performance. J. Anim. Sci. 18:1560 (Abstract).

Sinclair, J. H., and H. O. Kunkel. 1959. Variations in post-weaning development of ruminal mucosa in lambs. Proc. Soc. Exp. Biol. Med. 102:57.

Deyoe, C. W. August, 1959. Studies on ceruloplasmin of bovine serum. Dissertation, A and M College of Texas.

VI. PUBLICATIONS PLANNED:

Biochemical and Fundamental Physiological Bases of Genetically Variable Growth (A Review).

Table I. Coefficients of Correlations of Length of Papillae of the Ventral Sacs of Rumina to Rates of Gain and Weights of Lambs After 96-Day Feeding Period.

Variable	DES implant, 3 mg.	n	Product-moment	Within treatment groups[a]
96-day gain	-	86	0.475**	0.495**
	+	91	0.170	0.165
Final weight	-	86	0.260*	0.208
	+	91	0.318**	0.321
Initial weight	-	86	0.061	0.002
	+	91	0.312**	0.327**

[a]Fourteen treatment groups testing the effects of oxytetracycline, chlortetracycline, hydroxyzine, and teraphthalic acid, alone or in combination. No significant effects or papillary development were detected from these treatments.

Table II. Average Rates of Gain of Lambs Showing Partial Desquamation of Rumen Epithelium at End of 96-Day Feeding Trial.

Condition of Rumen	DES implant	n	Av. daily gain, lb.
Partial mucosal sloughing	-	13	0.356**
	+	10	0.482**
Healthy mucosa	-	86	0.486
	+	91	0.586

**Decrease in gain highly significant statistically (p 0.01).

Table III. Coefficients of a Correlation Among Concurrent (28-day) Rates of Gain, Serum Ceruloplasmin and Serum Alkaline Phosphatase of Lambs Fed Hexestrol and Hydroxyzine

Coefficient Of Correlation	Treatment groups		
	Control	Hexestrol, 15mg/head/day	Hydroxyzine, 7mg/head/day
n	10	9	10
$r_{cer.gain}$	-.79**	-.84**	-.82**
$r_{Pase.gain}$	0.11	0.80**	0.78**
$r_{cer\text{-}Pase}$	-.24	-.91**	-0.66*
$R_{cer,Pase.gain}$	0.79*	0.84*	0.88**

cer = ceruloplasmin; Pase = phosphatase

I. PROJECT: 959 (S-10)

Biochemical and Physiological Anomalies of Bovine Dwarfism and Their Use in Detection of Heterozygotes.

II. OBJECTIVES:

A. The detection of biochemical or physiological anomalies which may be associated with bovine dwarfism of various types, with an attempt to identify the metabolic defects which cause dwarfism.

B. The determination of the usefulness of biochemical or physiological anomalies, which may be detected in dwarfs, in the detection of heterozygotic phenotypically normal animals.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. During the year, research was directed to the investigation of the oxidative pathways involving glucose and glucose derivatives. The working hypothesis was that a deranged carbohydrate metabolism is related to the dwarfism characteristic. Differences were observed in the capacity for oxidation of glucose-6-phosphate and of 6-phosphogluconate, by erythrocytes from normal and dwarf animals.

B. Recent findings strongly indicate that the biochemical variations which were observed were the results of the particulate portions of the erythrocyte hemolysate. Thus differences in stromal structure seem evident but, as yet, unidentified.

IV. FUTURE PLANS:

Research will be continued in an effort to identify a primary biochemical basis for bovine dwarfism. Immediate efforts will be directed toward further study of the carbohydrate metabolism of the erythrocytes from dwarf and normal animals.

V. PUBLICATIONS DURING THE YEAR:

Deyoe, C. W., M. C. Shrode and H. O. Kunkel. 1959. Physiological responses to insulin-induced stress in osteodystrophic dwarf, dwarf-carrier and normal beef cattle. J. Anim. Sci. 18:1128-1134.

Virginia Station

by

J. A. Gaines

I. PROJECT: Hatch 93901 (S-10)(AHRD d1-7)

Heterosis from Crosses Among British Breeds of Beef Cattle

II. OBJECTIVES:

A. To measure heterosis obtained from crosses among Angus, Hereford and Shorthorn beef cattle as shown by growth rate, fattening ability, and carcass quality up to approximately two years of age.

B. To measure productive ability of dams.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Facilities and animals:

1. Facilities consist of one farm of 400 open acres equipped for livestock production (Shanandoah Valley Research Station) and one pasture of 200 acres at the main station.

2. Animals:

a. Six bulls - three purebred and three crossbred.
b. Number of cows in 1959 was 113.
c. Number of calves produced in spring, 1959 (third calf crop) and weaned in fall, 1959, was 93.

B. Research results:

1. Completed slaughter and summary of data on second calf crop, 1958 calves.

2. Weaned third calf crop.

IV. FUTURE PLANS:

A. Heifers from third calf crop will be slaughtered June 6, 1960.
B. Steers from third calf crop will be slaughtered January, 1961.
C. Fourth calf crop will be weaned in October, 1960.
D. Breeding for fifth calf crop will begin May 23, 1960.

V. PUBLICATIONS DURING THE YEAR:

Gaines, J. A., R. C. Carter and C. M. Kincaid, Genetic parameters concerned with feed efficiency in full fed beef cattle. Proc. of Virginia Academy of Science (May, 1960).

VI. PUBLICATIONS PLANNED:

An article in the Journal of Animal Science giving estimates of genetic parameters concerned with feed efficiency in full fed cattle.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)
Second Calf Crop

Virginia Agricultural Experiment Station

Location Line or group	Blacksburg, Virginia Purebred	 2-breed cross	 3-breed cross	 Backcross
STEERS, No.	12	15	8	11
Av. initial age (days)	553	552	548	549
Av. initial wt. (lbs.)	749	809	828	759
Av. no. days on feed	130	130	130	130
Av. final weight	1035	1087	1110	1042
Av. daily gain	2.20	2.15	2.17	2.17
Av. score				
Condition	10.5	11.1	10.9	10.8
HEIFERS, No.	9	9	14	14
Av. initial age (days)	213	212	208	209
Av. initial wt. (lbs.)	350	369	359	368
Av. no. days on feed	226	226	226	226
Av. final weight	743	763	742	767
Av. daily gain	1.74	1.74	1.69	1.75
Av. score				
Condition	11.2	12.0	12.7	12.6

DATA ON ANIMALS SLAUGHTERED
Second Calf Crop

Blacksburg, Virginia

Herd Sex	Purebred Steers	2-breed cross Steers	3-breed cross Steers	Backcross Steers
No. slaughtered	12	15	8	11
Age at slaughter	683	682	678	679
Time in feedlot (days)	130	130	130	130
Gain in feedlot (lbs.)	286	278	282	282
Final feedlot weight	1035	1087	1110	1042
Slaughter weight(1)	1035	1087	1110	1042
Carcass weight(2)	609	650	669	624
Dressing percentage(3)	58.9	59.8	60.2	60.0
Slaughter grade	10.5	11.1	10.9	10.8
Carcass grade	10.2	10.7	10.4	11.1
Rib eye area (sq. in.)	9.7	10.4	11.2	9.9

Steeles Tavern, Virginia

No. slaughtered	9	9	14	13
Age at slaughter	439	438	434	435
Time in feedlot (days)	226	226	226	226
Gain in feedlot (lbs.)	393	394	383	396
Final feedlot weight	743	763	742	767
Slaughter weight(1)	743	763	742	767
Carcass weight(2)	436	449	440	457
Dressing percentage(3)	58.6	58.8	59.3	59.5
Slaughter grade	11.2	12.0	12.7	12.6
Carcass grade	11.8	12.6	11.6	11.7
Rib eye area (sq. in.)	9.0	8.3	8.7	9.2
Fat thickness over rib eye (ins.)	2.1	2.4	2.4	2.0

(1) No time lapse; these are farm weights immediately prior to shipment.
(2) Hot.
(3) Farm weight and hot carcass weight.

PERFORMANCE OF COW HERDS. 1959 CALVES
Third Calf Crop

Virginia Agricultural Experiment Station

Location Line or group	Blacksburg, Virginia Purebred	 2-breed Cross	 3-breed Cross	 Backcross
No. cows calving	27	26	23	30
No. calves raised	25	26	22	30
Av. birth date	3/12	3/13	2/23	3/11
Av. birth wt. (lbs.)	65	68	70	70
Av. weaning age	212	211	229	213
Av. weaning wt.	427	422	484	442
Av. weaning type score	11.6	11.0	11.3	11.3
Were calves creep fed?	No	No	No	No
Av. daily gain from birth to weaning(1)	1.72	1.69	1.81	1.74

(1)No adjustment made. Data are as observed. Dams are all the same age and sex is ignored.

VA (6)

Virginia Station

by

T. J. Marlowe

I. PROJECT: S-031-8

Evaluation of the Effectiveness of Selection for Economic Traits in Beef Cattle.

II. OBJECTIVES:

A. To obtain estimates of genetic parameters from field data 1 to include:

1. Heritability and repeatability of traits.
2. Phenotypic and genetic correlations.
3. Proper weighting of traits in a selection index.

B. To study the effects of location on performance records.

C. To re-evaluate (and possibly identify others) the constants now being used in the Virginia BCIA program in correcting for non-genetic differences.

D. To study the relationship of mature weight of herd sires and dams to the performance of their offspring.

E. To determine the minimum postweaning gains required to obtain measurable genetic differences among animals.

F. To study the relationship among live animal measurements, type ratings, and growth rates.

G. To evaluate the effectiveness of selection on the improvement of beef cattle under farm conditions.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. Performance records are being accumulated on 6000 to 8000 calves and yearling cattle each year through the Virginia BCIA program. All of these records are being processed through the Experiment Station Computing Center. After the records have been computed, listed, and returned to the breeders the data become the property of the Experiment Station and are used for various types of studies as set forth in the objectives above. Additional information is being obtained on their sires and dams, as well as on individual animals themselves, as needed for these studies. All of the data are collected under field conditions and coded according to management practices.

B. This project was started during 1959 with the objectives shown above. Some progress has been made on objectives 1, 3, and 4. In the study to obtain estimates of heritability of growth rate and type score from field data, certain limitations were established in regard to feeding practices used, age of calf when weighed, minimum number of progeny per sire, and minimum number of sires per herd per year. These data are now in punched cards. They cover a period of six years, 83 herds, and 389 different sire progeny groups.

C. The constants now in use in correcting for non-genetic differences in growth rate were checked by summarizing by age of calf, sex of calf, month of birth of calf, and age of dam. They are shown in table 1 along with the number of calves and average age and weight in each classification. They appear to be doing a reasonably satisfactory job in equalizing the sub-group means with the exception of season of birth. These data also indicate that it is not necessary to adjust the growth rate of calves out of cows over ten years of age as has been done in the past.

D. Actual birth weights on 4,986 Angus calves and 4,666 Hereford calves were summarized by age of dam and sex of calf and related to the growth rate of the calves. These data are shown in table 2. Shown also are the range and standard deviation of birth weights, standard deviation of average daily gains, and regression and correlation coefficients, and F values for each classification. The pooled within phenotypic correlation between birth weight and average daily gain was..2354 and the comparable b value was .0078. One standard deviation for birth weight was approximately eleven pounds and for average daily gain .334 pounds.

E. The first step in reaching objective 4 was to study the factors that influence the mature weight and grade of beef bulls. A total of 945 live weights were obtained on 765 different bulls, 458 on bulls between 12 and 24 months, and 507 on bulls between 2 and 11 years of age. They were about equally divided in both age groups between Angus and Hereford. Each bull was scored on flesh condition on a scale from 1 to 5, 1 being the very thin bulls and 5 the fat bulls. Conventional least squares analysis was used to estimate the effects of breed, age, and flesh condition on the weight and grade within the two major age divisions. Estimates of these effects are shown in table 3 and 4. The R^2 values indicate that the effects studied accounted for a much higher percentage of the total variance within the younger group of bulls than within the older group. However, all factors studied had a highly significant effect on weight in both age divisions. Hereford bulls averaged 35 pounds heavier than Angus bulls at 12 months of age and 70 pounds heavier at maturity. Angus bulls graded about .3 of a grade point higher than Hereford bulls at 12 months of age and at maturity. The single greatest influence on weight was age. The average increase in weight per month of age was about 44 pounds from 12 to 16 months, 25 pounds from 17 to 30 months, and a little less than 10 pounds from

31 to 48 months with little change thereafter. Approximately one-half of the mature weight had been reached by 12 months of age. Adjusted average weight for 12 months old bulls was 741 pounds for Angus, and 776 pounds for Herefords. Adjusted mature weights were 1425 pounds for Anuus, 1495 pounds for Herefords. The grade (type score) increased slighly with age from 12 through 24 months with the total increase of approximately one grade point and remained relatively stable for older bulls. Flesh condition had a highly significant influence on both weight and grade even though a conscious effort had been made to discount flesh condition at the time each bull was graded. A unit change in flesh condition accounted for approximately .9 of a grade point in type in the younger age division and approximately .8 of a grade point in the older age division.

F. When all age groups were studied together the R^2 value increased to .74 indicating that the differences in breed, age and flesh condition accounted for about three-fourths of the total variation in weight. In contrast, the R^2 value for grade indicated that these factors accounted for only about one-third of the total variation in grade (type score). The adjusted weight at any given age was almost identical regardless of whether the estimate came from the study in which the two major age groups were studied independently or from the study in which all age groups were considered together. The same was true for adjusted grades.

Data has been collected on more than 1,500 cows for a similar study of the factors that influence weight and grade. The factors to be studied will include condition score, age, whether the cow was nursing a calf or not, breed, polled or horned, and perhaps others.

IV. FUTURE PLANS:

This project will be continued in accordance with the objectives listed above until they have been accomplished.

V. PUBLICATIONS DURING THE YEAR:

Marlowe, T. J., 1959. Performance and progeny testing of beef cattle in breeder's herds. Virginia Angus Handbook.

Marlowe, T. J. 1959. Performance testing of beef bulls in Virginia. The Performance Register. March, 1959.

Marlowe, T. J. 1959. An on-the-farm testing program for beef cattle. The Shorthorn World. August, 1959.

Marlowe, T. J. and J. A. Gaines. 1960. Factors affecting growth rate and type score of beef calves. Va. Agr. Expt. Station Report.

Marlowe, T. J., H. H. Dickenson, C. C. Mast and G. W. Litton. 1960. Performance testing of beef cattle in breeder's herds. Va. Agr. Expt. Station Report.

Marlowe, T. J., R. J. Freund and J. B. Graham. 1960. Some factors influencing the weight and grade of beef bulls. J. Anim. Sci. 19 (Abstract).

VI. PUBLICATIONS PLANNED:

Plan to present three papers to the Journal of Animal Science during the coming year. They will include one on the factors influencing the mature weight and grade of beef cows, and a third paper on additional estimates of the influence of age, sex, and season of birth of calf, and age of dam on the preweaning growth rate and type score of beef calves.

Table 1. Weight, daily gains, and type score on non-creep fed beef calves by age, sex, and month of birth of calf and age of dam

Trait	No. of Animals	Av. Age (days)	Average Weight	Average Daily Gain	Adjusted ADG*	Adjusted ADG**	Type Score
Age of Calf							
under 90	166	77	201	1.77	1.99	1.99	11.1
91-120	769	109	253	1.72	1.91	1.91	11.1
121-150	2295	137	295	1.68	1.85	1.85	11.3
151-180	3256	166	344	1.68	1.82	1.82	11.3
181-210	3823	195	385	1.64	1.78	1.78	11.4
211-240	3659	225	425	1.60	1.75	1.75	11.6
241-270	2052	257	454	1.53	1.72	1.72	11.6
271-300	918	281	470	1.44	1.63	1.63	11.4
Total of 16,938 calves	*Adjusted for sex, season of birth and age of dam						
Sex of Calf							
Bulls	1516	189	401	1.78	1.88	1.82	11.7
Heifers	8144	201	373	1.56	1.64	1.77	11.7
Steers	6409	201	400	1.67	1.76	1.76	11.1
Total of 16,069 calves	*Adjusted for season of birth and age of dam						
Month of Birth							
January	3452	221	420	1.61	1.72	1.72	11.6
February	3096	195	391	1.67	1.80	1.80	11.5
March	2773	168	347	1.68	1.83	1.83	11.4
April	1838	149	316	1.68	1.85	1.85	11.3
May	530	157	317	1.61	1.81	1.81	11.5
June	147	192	333	1.37	1.56	1.67	11.0
July	177	222	390	1.46	1.57	1.68	11.5
August	100	208	340	1.32	1.47	1.57	11.0
September	219	225	357	1.30	1.41	1.51	10.8
October	250	235	392	1.39	1.50	1.61	10.7
November	829	264	452	1.47	1.56	1.67	11.6
December	2165	244	441	1.54	1.64	1.75	11.5
Total of 15,576 calves	*Adjusted for sex of calf and age of dam						
Age of Dam							
2	1241	195	341	1.47	1.48	1.77	11.1
3	1675	196	368	1.57	1.61	1.77	11.3
4	1732	200	385	1.61	1.65	1.75	11.5
5	1548	203	400	1.66	1.72	1.77	11.7
6	1456	205	405	1.66	1.75	1.75	11.5
7	1099	201	406	1.70	1.78	1.78	11.6
8	885	204	410	1.69	1.78	1.78	11.4
9	650	203	407	1.69	1.79	1.79	11.4
10	420	201	405	1.64	1.80	1.80	11.3
11	256	206	413	1.69	1.76	1.85	11.6
12	188	195	383	1.63	1.70	1.78	11.3
13	109	199	397	1.67	1.80	1.89	11.2
14	79	193	382	1.64	1.70	1.96	11.0
15	52	199	390	1.63	1.70	1.95	11.2
16	24	201	370	1.52	1.58	1.82	9.5
17	7	172	364	1.74	1.78	2.00	10.4
18	5	152	328	1.73	1.74	2.01	10.8
Total of 11,426 calves	*Adjusted for sex and season of birth						

**Average daily gain adjusted for sex of calf, season of birth of calf, and age of dam.

Table 2. Birth weight and preweaning gains of Angus and Hereford calves by breed, sex of calf, and age of dam and their phenotypic relationship

Breed	Sex	Age of Dam	No. of Calves	Mean B. Wt.	Std. Dev.	Range	Mean ADG	Std. Dev.	b	r	F
Angus	Male	2	306	57.06	8.3	38-82	1.64	.564	.0112	.1754	9.65
Angus	Male	3	369	58.62	8.7	41-91	1.70	.334	.0081	.2171	18.16
Angus	Male	4	351	61.29	9.0	35-99	1.72	.291	.0076	.2390	21.14
Angus	Male	5	320	62.26	9.3	42-91	1.77	.332	.0068	.1981	12.99
Angus	Male	6	316	63.75	9.3	38-98	1.79	.336	.0086	.2433	19.76
Angus	Male	over 6	858	63.88	9.2	30-96	1.77	.328	.0063	.1812	29.06
Angus	Male	All	2520	61.82	9.4	30-99	1.74	.365	.0066	.1701	75.20
Angus	Female	2	356	52.71	8.7	30-88	1.44	.246	.0063	.2476	19.17
Angus	Female	3	348	55.04	8.1	38-85	1.54	.304	.0085	.2338	20.00
Angus	Female	4	350	56.94	8.8	38-90	1.57	.302	.0047	.1367	6.63
Angus	Female	5	333	58.51	9.2	35-93	1.60	.260	.0102	.1154	50.87
Angus	Female	6	286	58.93	9.1	35-98	1.64	.276	.0096	.2308	15.98
Angus	Female	over 6	793	59.44	9.2	30-89	1.61	.275	.0066	.2237	41.62
Angus	Female	All	2466	57.46	9.3	30-98	1.57	.284	.0064	.2090	112.48
Angus		All	4986	59.66	9.6	30-99	1.66	.338	.0081	.2300	280.56
Hereford	Male	2	289	64.66	11.1	40-90	1.56	.359	.0094	.2715	22.80
Hereford	Male	3	338	68.56	10.9	43-99	1.67	.339	.0087	.2524	22.87
Hereford	Male	4	335	70.95	10.8	46-99	1.71	.371	.0096	.2901	30.60
Hereford	Male	5	273	69.39	11.0	45-99	1.79	.286	.0070	.2505	18.13
Hereford	Male	6	246	72.00	10.6	49-99	1.76	.307	.0079	.2802	20.78
Hereford	Male	over 6	859	71.35	11.0	40-99	1.78	.362	.0043	.1324	15.28
Hereford	Male	All	2340	69.98	11.2	40-99	1.73	.354	.0067	.2044	101.99
Hereford	Female	2	299	62.10	10.7	33-98	1.46	.320	.0102	.3149	32.68
Hereford	Female	3	307	64.62	11.3	45-94	1.54	.286	.0099	.3582	44.86
Hereford	Female	4	313	66.57	9.7	45-98	1.54	.288	.0077	.2470	20.21
Hereford	Female	5	301	66.15	9.7	45-93	1.64	.270	.0083	.3025	30.11
Hereford	Female	6	245	68.25	9.5	39-95	1.62	.306	.0067	.2130	11.55
Hereford	Female	over 6	861	67.52	10.0	40-99	1.64	.285	.0063	.2202	43.75
Hereford	Female	All	2326	66.31	10.3	33-99	1.59	.294	.0071	.2373	138.75
Hereford		All	4666	68.16	10.9	33-99	1.66	.334	.0076	.2405	286.36
Combined			9652	63.77			1.66	.336	.0078	.2354	

Table 3. Least Squares estimates of the effects of breed, age, and flesh condition on the weight and type score of 12-24 month old bulls

Effects	Studied	Number Obser-vations	WEIGHT b Value	Std. Dev.	F Value[1]	Adj. Mean	TYPE SCORE[2] b Value	Std. Dev.	F Value[1]	Adj. Mean
Breed	Angus	212	0.0			741	0.000			12.40
	Hereford	226	34.9	10.4	11.36	776	-0.327	.125	6.93	12.17
Age in Months	12	64	00.0			741	0.000			12.40
	13	70	50.7	18.0	7.96	792	0.413	.216	3.67	12.81
	14	61	116.2	18.5	39.39	857	0.361	.222	2.63	12.76
	15	49	131.5	19.6	44.97	872	0.451	.236	3.67	12.85
	16	34	174.6	22.0	62.86	916	0.512	.264	3.75	12.91
	17-20	109	254.2	16.5	238.93	995	0.889	.197	20.29	13.29
	21-24	51	336.5	19.8	287.80	1078	0.887	.238	13.88	13.29
Flesh Condition	V. Thin	11	-267.8	10.3	68.29	473	-2.558	.389	43.23	9.84
	Thin	90	-146.2	14.0	108.71	595	-1.226	.168	53.02	11.17
	Average	160	0.0			741	0.000			12.40
	Good	152	103.3	11.7	77.45	844	0.544	.141	14.86	12.94
	Fat	25	154.5	22.4	47.62	895	1.114	.269	17.19	13.51
	bo	438	740.7	101.7		741	12.400	1.222		12.40

1. F. values above 3.86 significant at .05 level and above 6.70 at .01 level of probability.
2. Fancy 15-17, Choice 12-14, Good 9-11, etc.
3. R^2 for weight was .64 and for type score .32.

Table 4. Least squares estimates of the effects of breed, age, and flesh condition on the weight and type score of 2-11 year old bulls

Effects Studied		Number Obser-vations	WEIGHT				TYPE SCORE[2] [3]			
			b Value	Std. Dev.	F Value[1]	Adj. Mean	b Value	Std. Dev.	F Value[1]	Adj. Mean
Breed	Angus	238	00.0			1425	0.000			13.67
	Hereford	269	70.5	17.9	15.53	1495	-.320	.130	6.04	13.35
	25-30	62	-175.7	28.1	39.27	1249	-.096	.204	.22	13.57
	31-36	46	-185.3	31.6	34.34	1238	-.005	.230	.00	13.66
Age in	37-42	47	-106.5	31.5	11.45	1318	-.307	.299	1.80	13.36
Months	43-48	53	-107.0	30.0	12.70	1318	-.862	.219	15.56	12.81
	49-54	64	- 34.5	27.8	1.54	1390	-.195	.202	.93	13.47
	Over 54	235	000.0			1425	.000			13.67
	V. Thin	29	-329.2	39.6	69.22	1096	-1.994	.288	47.99	11.68
Flesh	Thin	132	-131.5	22.5	33.99	1294	- .680	.164	17.17	12.99
Condition	Average	182	000.0			1425	.000			13.67
	Good	137	80.6	22.3	13.05	1506	.791	.162	23.71	14.46
	Fat	27	218.6	41.2	28.16	1644	1.317	.299	19.30	14.99
	bo	507	1424.9	193.50		1425	13.668	1.410		13.67

1. F values above 3.86 are significant at the .05 level and above 6.70 at .01 level of probability.
2. Fancy 15-17, Choice 12-14, Good 9-11, etc.
3. R^2 for weight was .33 and for type score .27.

I. PROJECT: S-92186.

A Study of Dwarfism in Beef Cattle

II. OBJECTIVES:

A. To determine the pathogenises of dwarfism in beef cattle by finding:

1. The morphological site of gene expression.
2. The period during which gene expression operates.
3. The mode of action of the responsible gene.

B. Attempt to devise a method by which the dwarf carrier animal may be recognized at a young age.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. The major accomplishment during the year was the completion of a series of assays to compare the growth hormone content of the pituitary glands from dwarf and normal (genotype unknown) calves and the analysis of the data.

B. Pituitary glands from 30 dwarf and 30 normal calves of fairly comparable age, sex, and breed were assayed for growth hormone content. Since they were not completely comparable in every aspect an attempt was made to estimate and eliminate those differences in the analysis of the data. A series of four assays were conducted using hypophysectomized, immature, female rats as the assay animal and the tibia test as the measure of response. Conventional least squares analysis was used to estimate the effects of source of hormone, preparation of material, sex and breed of calf, level of injection, reader differences, and differences in initial rat weight on the width of the epiphyseal cartilage. The breed and approximate age of calves from which the glands came are shown in table 1 along with the portion of the gland used, drying procedure, number of glands assayed, and level of injection. In all trials, rats were injected for a period of four days and sacrificed 24 hours following the last injection.

In trial 1, glands from 15 dwarf and 15 normal calves were dried in acetone, the connective tissue capsules removed, and all glandular material macerated until a fine powder was obtained. Powder from each gland was suspended in sterile, physiological saline and injected in two rats at the rate of four mgm. of powder per day.

In trial 2, glands from five dwarf and five normal calves, all Herefords, were dried in acetone, the anterior lobe removed, powdered and suspended in sterile, physiological saline and injected in four rats on each of two levels (400 and 800 micrograms).

In trial 3, glands from three normal and three dwarf calves were dried in a calcium chloride desiccator, the anterior lobe removed, powdered and suspended in sterile, physiological saline and injected in eight rats at the rate of 400 micrograms per rat daily.

In trial 4, glands from seven dwarf and seven normal Hereford calves were dried in a frozen state, the anterior lobe removed, powdered and suspended in sterile, physiological saline. The material was then injected in six rats daily at the rate of 100 micrograms per day.

The unadjusted means of cartilage width by trial and treatment are shown in table 2.

Least squares estimates of the effects of sex of calf, type of material, level of injection, reader, and initial weight of rat on the width of the epiphyseal cartilage of the tibia of trial 2 are shown in table 3 and will serve as an example of how the data were analyzed.

Analysis of the data from the four trials indicated: (1) a significantly higher level of growth hormone per unit of pituitary powder from normal calves in three of the four trials, (2) the response from all treated groups was significantly greater than from the control groups, (3) air dried and freeze-dried preparations were more potent than acetone-dried preparations, (4) no significant difference due to sex of calf, (5) breed difference when acetone dried whole glandular powder was injected but no significant difference when air-dried anterior pituitary powder was used, (6) cartilage width increased as the level of injection increased as the level of injection increased from 0 to 800 micrograms of glandular powder based on 242 observations, (7) measurements by reader one were always significantly larger than those by reader two, and (8) adjusting for minor differences in initial rat weight within trials had only a small effect on cartilage width.

All of the mean values shown in table 2 are significantly different from all other means within each trial at the .01 level of probability with the exception of the mean values shown in trial 4 between dwarf and normal glands.

These data would indicate that there is a deficiency of growth hormone in the pituitary glands of the so-called "snorter" dwarf and that the dwarf gene is producing its effect at least in part by limiting the amount of growth hormone secretion.

IV. FUTURE PLANS:

An attempt will be made to complete all of the work now underway during the year and the project will probably be closed out.

V. PUBLICATIONS DURING THE YEAR:

Marlowe, T. J. 1960. Comparison of growth hormone content of pituitary glands from dwarf and normal beef calves. J. Anim. Sci. 19:647 (Abstract).

VI. PUBLICATIONS PLANNED:

An Experiment Station bulletin covering all of the research conducted at the Virginia Station on this problem.

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Table 1. Kind, preparation, and level of injection of materials used in assays for growth hormone content

Trial	Breed of Calf	Approx. Age of Calves (months)	Portion of Pituitary Gland Used	Drying Procedure	No. of Glands Assayed	Level of Daily Injections
1	Hereford, Angus and Shorthorn	4-6	Whole gland	Acetone	30	4.0 mgm.
2	Hereford	6-12	Anterior lobe	Acetone	10	0.4-0.8 mgm.
3	Angus, Hereford	4-6	Anterior lobe	Ba-chloride	6	0.4 mgm.
4	Hereford	4-5	Anterior lobe	Freeze-dried	14	0.1 mgm.

Table 2. Unadjusted means of cartilage width by trial and treatment

Trials	1	2	3	4	1	2	3	4
Treatment	No. Observations				Cartilage Width (micra)			
Saline Control	58	20	8	13	90.0	105.1	105.2	93.1
Dwarf Gland	58	96	38	39	136.4	145.9	166.0	183.8
Normal Gland	60	96	44	36	173.9	153.9	179.8	186.8

Table 3. Least squares estimates of the effects of sex of calf, type of material, level of injection, reader, and initial weight of rat on the width of the epiphyseal cartilage of the tibia

Effects		No. of Observations	No adjustment for rat wt. b-values*	Standard error	F value	Adjusted for initial rat wt. b-values*	Standard error	F value
Sex	(2.1 Bull	32	-2.895	±4.14	0.49	-2.986	±4.24	0.50
	(2.2 Heifer	128	0.000			0.000		
	(2.3 Composite	32	-5.551	±4.14	1.80	-5.559	±4.15	1.80
Type of Material	(4.1 Saline	20	0.000			0.000		
	(4.2 Normal	96	41.753	±5.46	58.31**	41.727	±5.48	57.85**
	(4.3 Dwarf	96	33.855	±5.46	38.34**	33.811	±5.50	37.83**
Level	(5.4 400 microgram	96	0.000			0.000		
	(5.6 800 microgram	96	16.771	±3.02	30.81**	16.814	±3.06	30.27**
Reader	(7.1 T.J.M.	106	00.000			00.000		
	(7.2 M.K.	106	-13.457	±2.87	21.90**	-13.457	±2.88	21.80**
Rat. wt.	(x_1 Initial	212				0.039	±0.33	0.01
	bo	212	211.878			108.936		

*Estimated effect on cartilage width measured in micra.
**Significant at 1% level.

Northern Virginia Pasture Research Station

Middleburg, Virginia

The Northern Virginia Pasture Research Station maintains a purebred Angus herd of approximately 60 cows and 4 herd sires. The cows are bred to calve during the summer in order that they may be weaned in March and the entire calf crop used for grazing tests on the Station.

From the 60 cows bred during the fall of 1958, 54 calved and 51 calves were raised to weaning. The average birth date was July 28, 1958 and all calves were weaned on March 16, 1959. The performance records by sire progeny groups are shown in table 1.

Table 1. Preweaning Performance of 1958 Calves by Sire Progeny Groups

Sire No.	Offspring	Age in Days	Wt.	ADG	Adjusted ADG[1]	Type Score[2]	Index Value
Unknown	6	187	317	1.39	1.73	9.3	98
176	3	218	363	1.42	1.73	11.0	106
405[3]	11	239	498	1.81	1.96	12.7	124
R71	14	235	461	1.66	1.83	11.9	114
WA22	13	235	446	1.64	1.80	11.2	110

[1]Gain adjusted for sex of calf, season of birth and age of dam.
[2]Type Score: Fancy 15-17; Choice 12-14; Good 9-11, etc.
[3]Sire 405 is a son of sire WA22.

The number of calves raised, average birth date and weight, average weaning age and weight, average type score and adjusted average daily gain from birth to weaning for the 1959 calf crop was as follows:

No. cows calving	54	Av. weaning age	241 days(1)
No. calves raised	51	Av. weaning wt.	441 lbs.(2)
Av. birth date	7/24	Av. type score	11.3
Av. birth weight	57 lbs.	Adjusted ADG	1.83

[1]The average is based on date nursing calves were weaned in March, although some calves were weaned in November.
[2]Sample of calves weaned at 4 months of age to study gain from supplementary feeding in absence of dam's milk. Other calves received different amounts of supplement in addition to dam's milk.

Beef Cattle Research Station
Front Royal, Virginia

by

K. P. Bovard and B. M. Priode

I. PROJECT: A. H. 150.16 (S-10)(AHRD dl-4)

The Improvement of Beef Cattle for Virginia Through Breeding Methods

II. OBJECTIVES:

A. Beef cattle research projects are conducted with three breeds of cattle (Angus, Hereford, and Shorthorn) and are associated with problems relating to the improvement of beef cattle for Virginia through breeding methods. The objectives of the investigation are as follows:

1. To estimate the progress to be expected from mass selection as compared with family selection in the improvement of beef cattle.

2. To evaluate selection criteria and procedures and develop more precise and effective measures of quality and performance in beef cattle.

3. To simplify methods of progeny or sib testing whereby breeding cattle can be evaluated at comparatively young ages.

B. The long-term breeding program for the work at Front Royal may be roughly sub-divided into five phases, each of which has some direct bearing on the main objectives stated above:

1. Test from weaning to yearling age those bull calves which appear to be herd-sire prospects on the basis of their pre-weaning performance.

2. Progeny test as yearlings those bulls with favorable records from Phase 1.

3. Choose as foundation sires those bulls with good records from Phases 1 and 2. Obtain 32 daughters by each foundation sire and out of unrelated cows.

4. Allot 32 daughters from each foundation sire as follows: 16 are placed back with their sire to form an inbred line; 8 become part of a growth herd where selection emphasis is on growth; and 8 become part of a type herd where selection emphasis is on type. For each breeding plan, measure the progress in terms of changes in growth rate and conformation. Compare the actual results with those expected from theoretical considerations.

5. Test inbred lines for combining ability and outcross performance.

III. ACCOMBLISHMENTS DURING THE YEAR:

A. Facilities: Equipment - (1) To facilitate artificial breeding and other work in the future, nine permanent catch-pens, at least 40' x 40' were erected. Most were located to serve two or more pastures. (2) Photographic equipment (camera, slide projector, and screen) were purchased. (3) A set of Howe scales, 6000 pound capacity, was installed.

B. Animals: Cattle - One crossbred, four Angus, and three Shorthorn bulls were obtained from outside sources in September and placed on the 1959-1960 R.O.P. tests. These bulls, along with an Angus, a Hereford, and a Shorthorn from VPI, will permit comparisons of Front Royal stock with unrelated animals.

C. Cattle inventory was 640 on January 1, 1959 and was 658 on December 31, 19[illegible]

IV. RESEARCH RESULTS:

In addition to the standard performance results reported below, the following findings are of interest:

A. Effects of inbreeding on weaning type scores and growth rates of 131 calves born in 1959:

Breed	Group	No. of Calves	Weaning Type Score	Average Daily Gain: Weaning	Average Daily Gain: R.O.P. First 112 Days
Angus	Inbred	27	10.3	1.57	1.60
	Selection	35	10.6	1.68	1.76
Shorthorn	Inbred	31	10.2	1.38	1.81
	Selection	38	10.9	1.49	1.98

It is apparent that inbreeding adversely affects conformation and growth rate, both pre-weaning and post-weaning.

B. Twenty bulls were hand-mated to 41 virgin heifers for Vibrio test purposes during February, March, and April. Two bulls were diagnosed as infected, the remainder were believed Vibrio-free. Two diagnostic tests were used: (1) the virgin-heifer test, and (2) the semen culture test. Only a few bulls were tested using both techniques; agreement between findings from the two different methods was not established.

C. Type scores were assigned to 240 calves born in 1959 by six men at Midsummer (July 1) and in the Fall (September 8). Statistically significant differences were found at both times (1) among graders and (2) among breeds. Grader-breed interactions were small. Sex differences

were small at Midsummer, significant in the Fall. Differences among graders in the size of the standard deviation of conformation scored among calves indicate variation in the use of the available scoring range. Without visual inspection of the calves, but rather by reference to each animal's record for weight and age, ratings were assigned to 119 heifer calves at Midsummer. These ratings were correlated with average type score (r=0.62) and with average condition score (r=0.75).

D. A preliminary study of 2268 cow weights from 1957 through 1959 indicates winter weight losses and subsequent summer weight gains are of the order of 130 pounds per head.

E. Studies in progress with 6 crossbred heifers indicate that legal tolerance levels of DDT (7 parts per million) in internal fat are rapidly approached and exceeded when feeds containing excessive DDT are fed. Following withdrawal of DDT-contaminated feeds from the ration, DDT residues in internal fat are very slowly dissipated.

V. FUTURE PLANS:

A. Individual feeding of R.O.P. bulls will be discontinued. Group-feeding of these animals is planned for 1960, and thereafter.

B. A. I. Breeding - all cattle in the 1960 breeding herds will be bred artificially in compliance with recommendations of health authorities as a Vibrio control measure.

VI. PUBLICATIONS DURING THE YEAR:

Carter, R. C. and C. M. Kincaid. 1959. Estimates of genetic and phenotypic parameters in beef cattle. II. Heritability estimates from parent-offspring and half-sib resemblances. J. Anim. Sci. 18:323-330.

Carter, R. C. and C. M. Kincaid. 1959. Estimates of genetic and phenotypic parameters in beef cattle. III. Genetic and phenotypic correlations among economic characters. J. Anim. Sci. 18:331-335.

Lehman, R. P., J. A. Gaines, R. C. Carter and K. P. Bovard. A selection index for beef calves at weaning. Proc. S-10 Technical Committee.

Thornton, J. W. and J. Wiltbank. Breed and sire differences in gestation length of beef cattle. J. Anim. Sci. 18:1153 (Abstract) from Proc. Sou. Section, A.S.A.P.

VII: PUBLICATIONS PLANNED:

Wiltbank, J. N., E. J. Warwick, E. H. Vernon and B. M. Priode. Reproductive losses in beef. Manuscript.

Bovard, K. P. Hereditary Dwarfism in Beef Cattle.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia Station

Location	---Front Royal, Virginia---				
Line or group	59	57	420	890	1349
Breed of sire	Angus	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus	Angus
No. cows calving	6	11	5	14	13
No. calves raised	3	11	4	9	9
Av. birth date	4/1	2/4	3/6	2/19	2/16
Av. birth wt. (lbs.)	65	57	55	58	59
Av. weaning age	146	202	172	187	191
Av. weaning wt.	358[2]	365	316	315	325
Av. weaning type score	10.6[3]	11.8	10.2	9.8	10.4
Av. weaning condition score	9:0	10.3	8.6	8.7	9.5
Were calves creep fed?	No	No	No	No	No
Adjusted[1] av. daily gain from birth to weaning	1.63	1.71	1.45	1.43	1.48

(1) Adjusted for age of dam.
(2) Adjusted A.D.G. times 180 days plus Av. Birth Wt.
(3) Results from bull and heifer calves were weighted equally to obtain the average values above for each line of breeding.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia

Location	Front Royal, Virginia				
Line or group	1376	1293	1390	8802	Unknown
Breed of sire	Angus	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus	Angus
No. cows calving	11	11	14	12	1
No. calves raised	7	8	11	11	1
Av. birth date	3/3	4/2	2/22	1/31	5/1
Av. birth wt. (lbs.)	59	63	58	63	70
Av. weaning age	175	146	184	206	116
Av. weaning wt.	372	400	350	400	473
Av. weaning type score	12.3	10.9	10.1	12.7	13.3
Av. weaning condition score	10.5	9.4	9.1	10.9	10.8
Were calves creep fed?	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.74	1.87	1.62	1.87	2.24

(1) Adjusted for age of dam.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia Station

Location	Front Royal, Virginia				
Line or group	322	373	8801	82	8803
Breed of sire	Hereford	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford	Hereford
No. cows calving	26	11	20	16	16
No. calves raised	24	9	19	15	13
Av. birth date	2/18	3/16	2/27	2/16	2/24
Av. birth wt. (lbs.)	66	67	65	66	63
Av. weaning age	188	162	179	190	182
Av. weaning wt.	341	359	346	352	383
Av. weaning type score	11.4	9.9	11.0	11.6	12.2
Av. weaning condition score	9.9	8.8	9.5	10.1	10.3
Were calves creep fed?	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.53	1.62	1.56	1.59	1.78

(1) Adjusted for age of dam.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia Station

Location	Front Royal, Virginia				
Line or group	885	1176	287	114	1443
Breed of sire	Shorthorn	Shorthorn	Shorthorn	Shorthorn	Shorthorn
Breed of dam	Shorthorn	Shorthorn	Shorthorn	Shorthorn	Shorthorn
No. cows calving	11	9	9	17	13
No. calves raised	9	5	6	15	9
Av. birth date	2/22	2/24	3/11	2/27	2/11
Av. birth wt. (lbs.)	71	69	58	68	65
Av. weaning age	184	183	168	179	196
Av. weaning wt.	330	287	321	316	319
Av. weaning type score	10.2	9.2	11.4	10.5	10.8
Av. weaning condition score	9.0	8.1	9.2	8.9	9.3
Were calves creep fed?	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.44	1.21	1.46	1.38	1.41

(1) Adjusted for age of dam.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia Station

Location	Front Royal, Virginia				
Line or group	1255	1463	1465	57	420
Breed of sire	Shorthorn	Shorthorn	Shorthorn	Angus	Angus
Breed of dam	Shorthorn	Shorthorn	Shorthorn	Shorthorn	Hereford
No. cows calving	9	12	11	2	5
No. calves raised	8	11	6	2	5
Av. birth date	2/9	2/9	2/17	3/1	3/8
Av. birth wt. (lbs.)	66	71	68	71	70
Av. weaning age	197	196	190	178	171
Av. weaning wt.	320	354	349	357	414
Av. weaning type score	11.4	10.3	11.2	9.7	11.3
Av. weaning condition score	9.4	9.4	9.7	8.9	10.0
Were calves creep fed?	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.41	1.57	1.56	1.59	1.91

(1) Adjusted for age of dam.

PERFORMANCE OF COW HERDS. 1959 CALVES

Front Royal, Virginia Station

Location	Front Royal, Virginia					
Line or group	420	890	890	Unknown	Unknown	8801
Breed of sire	Angus	Angus	Angus	Angus	Angus	Hereford
Breed of dam	Shorthorn	Hereford	Shorthorn	Hereford	Shorthorn	Angus
No. cows calving	4	4	3	1	1	1
No. calves raised	3	3	3	1	1	1
Av. birth date	3/3	2/27	2/12	6/7	2/7	3/15
Av. birth wt. (lbs.)	57	65	79	65	92	58
Av. weaning age	174	180	195	179	200	163
Av. weaning wt.	329	407	389	427	466	382
Av. weaning type score	10.3	11.6	11.1	10.5	11.0	12.7
Av. weaning condition score	9.4	10.1	9.7	9.3	10.4	10.8
Were calves creep fed?	No	No	No	No	No	No
Adjusted(1) av. daily gain from birth to weaning	1.51	1.90	1.72	2.01	2.08	1.80

(1) Adjusted for age of dam.

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Front Royal, Virginia Station

Location	-------Front Royal, Virginia-------			
Line or group	59	57	420	890
Breed of sire	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus
BULLS, No.	3	2	3	2
Av. initial age (days)	203	231	234	205
Av. initial wt. (lbs.)	517	422	448	317
Av. no. days on feed	168	168	168	168
Av. final weight	933	745	907	695
Av. daily gain	2.47	1.92	2.73	2.25
Av. score				
Conformation	11.6	11.0	10.7	9.4
Av. feed per day				
Concentrates Roughage	21.10	17.90	22.76	17.55
Feeding regime	-------Self fed - ad lib			
STEERS, No.	2	3		
Av. initial age (days)	248	258		
Av. initial wt. (lbs.)	442	499		
Av. no. days on feed	196	196		
Av. final weight	793	838		
Av. daily gain	1.80	1.73		
Av. score				
Conformation	12.9	11.0		
Condition	12.2	11.0		
Feeding regime	-------Group fed - ad lib-------			
HEIFERS, No.	4	5		2
Av. initial age (days)	242	253		180
Av. initial wt. (lbs.)	449	428		348
Av. no. days on feed	140	140		140
Av. final weight	605	583		543
Av. daily gain	1.12	1.11		1.39
Av. score				
Conformation	10.8	10.9		9.7
Feeding regime	-------Group fed - limited grain-----			

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Front Royal, Virginia Station

Location	Front Royal, Virginia			
Line or group	1165	1209	0115	150
Breed of sire	Angus	Angus	Angus	Angus
Breed of dam	Angus	Angus	Angus	Angus
BULLS, No.	3	3	2	2
Av. initial age (days)	223	197	238	234
Av. initial wt. (lbs.)	479	506	457	500
Av. no. days on feed	168	168	168	168
Av. final weight	869	904	841	869
Av. daily gain	2.32	2.37	2.29	2.20
Av. score				
Conformation	12.7	11.1	11.0	11.3
Av. feed per day				
Concentrates				
Roughage	21.71	20.78	20.59	20.62
Feeding regime	Self fed - ad lib			
STEERS, No.	6	1		
Av. initial age (days)	249	259		
Av. initial wt. (lbs.)	516	550		
Av. no. days on feed	196	196		
Av. final weight	917	1004		
Av. daily gain	2.05	2.32		
Av. score				
Conformation	13.3	12.2		
Condition	13.7	12.5		
Feeding regime	Group fed - ad lib			
HEIFERS, No.	5	6		
Av. initial age (days)	247	221		
Av. initial wt. (lbs.)	474	433		
Av. no. days on feed	140	140		
Av. final weight	631	604		
Av. daily gain	1.12	1.22		
Av. score				
Conformation	12.5	11.1		
Feeding regime	Group fed - limited grain			

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Front Royal, Virginia Station

Location	--------Front Royal, Virginia--------			
Line or group	R322	373	R82	R26
Breed of sire	Hereford	Hereford	Hereford	Hereford
Breed of dam	Hereford	Hereford	Hereford	Hereford
BULLS, No.	3	3	1	1
Av. initial age (days)	221	222	212	205
Av. initial wt. (lbs)	521	495	477	574
Av. no. days on feed	168	168	168	168
Av. final weight	903	921	898	941
Av. daily gain	2.28	2.54	2.51	2.18
Av. score				
Conformation	11.9	10.2	10.6	9.6
Av. feed per day				
Concentrates] Roughage] --	20.53	20.84	18.49	20.25
Feeding regime	----------Self fed - ad lib ----------			
STEERS, No.	3	3		
Av. initial age (days)	246	236		
Av. initial wt. (lbs.)	431	447		
Av. no. days on feed	196	196		
Av. final weight	814	910		
Av. daily gain	1.95	2.36		
Av. score				
Conformation	12.5	12.1		
Condition	11.4	12.4		
Feeding regime	------------Group fed - ad lib------------			
HEIFERS, No.	5	11		12
Av. initial age (days)	242	249		243
Av. initial wt. (lbs.)	392	427		406
Av. no. days on feed	140	140		140
Av. final weight	541	603		569
Av. daily gain	1.06	1.26		1.17
Av. score				
Conformation	10.0	10.3		10.8
Feeding regime	-----------Group fed - limited grain-----------			

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Front Royal, Virginia Station

Location	Front Royal, Virginia			
Line or group	12	885	1176	114
Breed of sire	Hereford	Shorthorn	Shorthorn	Shorthorn
Breed of dam	Hereford	Shorthorn	Shorthorn	Shorthorn
BULLS, No.		2	2	2
Av. initial age (days)		221	204	230
Av. initial wt. (lbs.)		410	470	430
Av. no. days on feed		168	168	168
Av. final weight		865	872	837
Av. daily gain		2.71	2.39	2.42
Av. score				
Conformation		8.7	10.9	9.6
Av. feed per day				
Concentrates] Roughage]---		23.24	22.25	20.30
Feeding regime	Self fed - ad lib			
STEERS, No.		1	2	3
Av. initial age (days)		262	221	257
Av. initial wt. (lbs.)		433	416	425
Av. no. days on feed		196	196	196
Av. final weight		850	849	835
Av. daily gain		2.08	2.22	2.20
Av. score				
Conformation		10.5	12.2	13.1
Condition		11.0	11.5	11.9
Feeding regime	Group fed - ad lib			
HEIFERS, No.	1	4	3	5
Av. initial age (days)	195	250	221	240
Av. initial wt. (lbs.)	387	394	376	385
Av. no. days on feed	140	140	140	140
Av. final weight	534	610	592	564
Av. daily gain	1.05	1.54	1.54	1.28
Av. score				
Conformation	10.6	10.3	13.4	11.4
Feeding regime	Group fed - limited grain			

POSTWEANING PERFORMANCE OF 1958 CALVES FULL FED AFTER WEANING
(or pastured for high gains)

Front Royal, Virginia Station

Location	----------Front Royal, Virginia----------			
Line or group	1255	D-29	1009	287
Breed of sire	Shorthorn	Shorthorn	Shorthorn	Shorthorn
Breed of dam	Shorthorn	Shorthorn	Shorthorn	Shorthorn
BULLS, No.	2	3	2	
Av. initial age (days)	216	182	216	
Av. initial wt. (lbs.)	404	396	469	
Av. no. days on feed	168	168	168	
Av. final weight	818	807	926	
Av. daily gain	2.47	2.45	2.72	
Av. score				
Conformation	10.5	9.5	10.3	
Av. feed per day				
Concentrates] -- Roughage]	21.71	21.01	23.18	
Feeding regime	------------Self fed - ad lib------------			
HEIFERS, No.	1	4	6	5
Av. initial age (days)	258	252	257	219
Av. initial wt. (lbs.)	436	445	433	423
Av. no. days on feed	140	140	140	140
Av. final weight	642	677	658	619
Av. daily gain	1.47	1.66	1.61	1.40
Av. score				
Conformation	12.8	12.1	12.1	12.1
Feeding regime	-------------Group fed - limited grain----------			

West Virginia University

I. PROJECT: Hatch 90 (S-10)

Reproduction Efficiency of Beef Cattle

II. OBJECTIVES:

A. To determine the practicability and effects of breeding beef cows at first heat following parturition.

B. To determine the incidence of ovulatory anomolies in beef cattle and their effects on reproductive performance.

C. To compare the reproductive efficiency of two breeds of beef cattle when managed under like conditions.

III. ACCOMPLISHMENTS DURING THE YEAR:

A. The West Virginia University purebred Angus and Hereford herds each with approximately 50 breeding females have been on this experiment for the past four years.

B. Data has been gathered on 255 service periods (calving to conception). These service periods include 137 from the Angus herd and 118 from the Hereford herd. The mean length of service period was 75.6 days when data from both herds were combined. Various components of the service period were studied. It was found that the largest component of the service period was from calving to the formation of the first corpus luteum. This interval averaged 38.9 days and comprised 51.5% of the total period. The period from formation of the first corpus luteum to first heat averaged 14.9 days and comprised 19.7% of the total period. The period from first heat to conception averaged 21.8 days and made up 28.8% of the service period.

C. The fertility of cows bred before and after involution of the uterus at various intervals after calving has been studied and the conclusion drawn that the length of the interval from calving to first breeding is of more importance in fertility than is the involutionary state of the uterus.

D. A master thesis has been recently completed on the first four year's work and a paper for publication is now being prepared.

I. PROJECT: C. E. 118

The Effects of Two Systems of Selection of Breeding Stock on Beef Cattle Performance.

II. OBJECTIVES:

This project is an attempt to apply a selection index procedure to a commercial beef cattle enterprise and evaluate its effectiveness in terms of both theoretical gains expected and actual gain as compared to a non-selected population.

III: RESEARCH RESULTS:

A. The grade Hereford herd, Reymann Memorial Farms, Wardensville, West Virginia, which consists of 100 breeding age females is on this experiment. The animals are divided into two groups A and B. The essential mechanics of selection in A groups are:

1. The necessary number of female replacements are drawn at random from the normal healthy calves born each year.

2. The necessary number of males are drawn at random from the normal healthy bull calves born each year.

3. Females of breeding age, other than those lost through death, failure to conceive, or other diseases are discarded at random.

B. In group B females and males are raised and selected on the basis of an indexing procedure based on weaning weight and weaning score.

C. This program has only been fully implimented during the past year, so the first calves produced by animals selected on this program will be weaned in the fall.

PERFORMANCE OF COW HERDS. 1959 CALVES

West Virginia Station

Location Line or group Breed of sire Breed of dam	Morgantown Hereford Hereford Hereford	Morgantown Angus Angus Angus
No. cows calving No. calves raised	39 37	37 35
Av. birth wt. (lbs.)	65.5	61.1
Av. weaning age Av. weaning wt.[(a)]	205 days 340.9	205 days 342.3
Av. weaning type score[(b)]	12.8	11.7
Were calves creep fed?	Yes	Yes
Adjusted av. daily gain from birth to weaning[(c)]	1.34	1.37

(a) Weight adjusted to 205 day basis.
(b) Based on 17 point score.
(c) Adjusted for age of calf.

Joint Meeting
S-10, W-1 and NC-1 Technical Committees
Oklahoma State University
Stillwater, Olkahoma

Program
July 25, 1960

Morning Session
Kieth E. Gregory, Presiding

Welcome by Dr. O. S. Wilham, President, Oklahoma State University
Response - Dean Sherman S. Wheeler, Colorado State University

Inbreeding and Heterosis in Beef Cattle

a. W-1 H. H. Stonaker
b. NC-1 C. A. Dinkel
c. S-10 C. M. Kincaid
d. Discussion Leader L. N. Hazel

Afternoon Session
R. T. Clark, Presiding

Evaluating the Effectiveness of Selection in Beef Cattle

a. Experimental measurement of response to selection
   C. E. Dickerson, Kimber Farms, Inc., Fremont, California
b. Operation and usefulness of a random bred control population of Rambouillet sheep C. E. Terrill and S. K. Ercanbrack

Genetic-environmental Interactions J. L. Lush
Discussion Leader - Wade Rollins

Evening Session
Dean Sherman S. Wheeler, Presiding

Moving Picture - Levels of Wintering for Beef Cows
Shown by Dr. Frank Baker

Working Together for a More Effective Beef Cattle Breeding Research Program - Dr. E. J. Warwick

July 26, 1960

Teaching Herds and Identical Twins at Stillwater - Robert Totuseck and Glenn Bratcher

Left Stillwater at 8:00 a.m. and traveled by bus to Fort Reno Station, El Reno, Oklahoma.

Morning Session
Fort Reno
Glenn Bratcher, Presiding

a. Levels of Feeding Beef Cows and Heifers
   L. S. Pope and Doyle Chambers
b. Tour of Swine Project
   J. A. Whatley, Jr.

Afternoon Session
Dr. E. J. Warwick, Presiding

a. Levels of Feeding Beef Heifers
   C. S. Hobbs, University of Tennessee
b. Dwarfism Research - Fort Reno
   Joe V. Whiteman
d. Beef Cattle Breeding Research - Fort Reno
   Doyle Chambers

Tour of Fort Reno Station - Dwight Stephens, Supt., Fort Reno Station

a. Groups of Commercial Angus Heifers
b. Registered Breeding Herds

Persons attending meeting were as follows:

NC-1 Technical Committee Members

H. W. Norton, University of Illinois, Urbana, Illinois
V. A. Garwood, Purdue University, Lafayette, Indiana
L. N. Hazel, Iowa State College, Ames, Iowa
Walter Smith, Kansas State College, Manhattan, Kansas
W. T. Magee, Michigan State University, East Lansing, Michigan
R. E. Comstock, College of Agriculture, St. Paul 1, Minnesota
James E. Comfort, University of Missouri, Columbia, Missouri
John F. Lasley, University of Missouri, Columbia, Missouri
Robert M. Koch, Agricultural Experiment Station, Lincoln 3, Nebraska
M. L. Buchanan, North Dakota A and M College, Fargo, North Dakota
Earle Klosterman, Ohio Agricultural Experiment Station, Wooster, Ohio
Doyle Chambers, Oklahoma A and M College, Stillwater, Oklahoma
C. A. Dinkel, South Dakota State College, College Station, S. Dakota
E. R. Hauser, University of Wisconsin, Madison, Wisconsin
Keith E. Gregory, Coordinator, University of Nebraska, Lincoln, Neb.

Other Project Workers in NC-1

G. F. Cmarik, Dixon Springs Experiment Station, Robbs, Illinois
Raymond L. Burns, Purdue University, Lafayette, Indiana
J. L. Lush, Iowa State College, Ames, Iowa
G. L. Parks, Iowa State College, Ames, Iowa
L. E. Johnson, Iowa State College, Ames, Iowa
John D. Wheat, Kansas State College, Manhattan, Kansas
Byron Greiman, University of Missouri, Columbia, Missouri
Walt Rowden, Fort Robinson, Crawford, Nebraska
Duane Zimmerman, University of Nebraska, Lincoln, Nebraska
Vincent Arthaud, University of Nebraska, Lincoln, Nebraska
E. J. Turman, Oklahoma State University, Stillwater, Oklahoma
B. J. Rankin, Oklahoma State University, Stillwater, Oklahoma
J. A. Whatley, Oklahoma State University, Stillwater, Oklahoma
Glenn Bratcher, Oklahoma State University, Stillwater, Oklahoma
M. J. Fitzgerald
J. A. Minyard, South Dakota State College, College Station, S.D.
L. L. Wilson, South Dakota State College, College Station, S.D.
J. E. Ingalls, Fort Robinson, Crawford, Nebraska
J. N. Wiltbank, Fort Robinson, Crawford, Nebraska
L. A. Swinger, University of Nebraska, Lincoln, Nebraska
Dwight Stephens, Fort Reno Experiment Station, El Reno, Oklahoma

W-1 Technical Committee Members

O. F. Pahnish, University of Arizona, Tuscon, Arizona
W. C. Rollins, University of California, Davis, California
H. H. Stonaker, Colorado A and M College, Fort Collins, Colorado
E. H. Cobb, University of Hawaii, Honolulu, Hawaii
R. E. Christian, University of Idaho, Moscow, Idaho
F. S. Willson, Montana State College, Bozeman, Montana
W. D. Foote, University of Nevada, Reno, Nevada

L. A. Holland, New Mexico State University, University Park, N. M.
Ralph Bogart, Oregon State College, Corvallis, Oregon
J. A. Bennett, Utah State Agriculture College, Logan, Utah
C. C. O'Mary, Washington State University, Pullman, Washington
George Nelms, University of Wyoming, Laramie, Wyoming
Nat Kieffer, U. S. Range Livestock Experiment Station, Miles City, Mon
R. T. Clark, Coordinator, USDA, ARS, Denver, Colorado

S-10 Technical Committee Members

See page 191 , S-10 Technical Committee Meeting

Visitors

C. J. Brown, University of Arkansas, Fayetteville, Arkansas
P. R. Noland, University of Arkansas, Fayetteville, Arkansas
Jim Brinks, USDA, Denver, Colorado
Tom Sutherland, Colorado State University, Fort Collins, Colorado
F. M. Peacock, Range Cattle Experiment Station, Ona, Florida
W. C. Burns, USDA, Brooksville, Florida
Jim Hentges, University of Florida, Gainesville, Florida
G. E. Dickerson, Kimber Farms, Inc., Fremont, California
J. C. Dollahon, Reata, Inc., Gazelhurst, Georgia
Walter Neville, Ga. Agriculture Experiment Station, Experiment, Ga.
T. M. Clyburn, Ga. Coastal Plains Experiment Station, Reidsville, Ga.
Donald Price, USDA, Dubois, Iowa
S. K. Ercanbrack, USDA, Dubois, Iowa
C. V. Hulet, USDA, Dubois, Iowa
H. L. Self, Iowa State University, Ames, Iowa
W. E. Urban, Iowa State University, Ames, Iowa
J. L. Gill, Iowa State University, Ames, Iowa
Dewey L. Harris, Iowa State University, Ames, Iowa
Charles E. Shelby, USDA, Ames, Iowa
Charan Chantalakhama, Iowa State University, Ames, Iowa
Carlos Lopez Sauhidet, Iowa State University, Ames, Iowa
R. C. DeBaca, Iowa State University, Ames, Iowa
Harold G. Spies, Kansas State University, Manhattan, Kansas
Ralph Boulware, Louisiana State University, Baton Rouge, Louisiana
T. M. DeRouen, Iberia Livestock Experiment Station, Jeanerette, La.
Lamar Reynolds, Iberia Livestock Experiment Station, Jeanerette, La.
R. A. Damon, Jr., USDA, Beltsville, Maryland
Walter R. Harvey, USDA, Beltsville, Maryland
John H. Zeller, USDA, Beltsville, Maryland
H. O. Hetzer, USDA, Beltsville, Maryland
Bill Backus, Mississippi State University, State College, Mississippi
L. P. McCann, American Hereford Association, Kansas City, Missouri
John W. Massey, American Agricultural Services, Columbia, Missouri
Charles E. Gates, University of Minnesota, St. Paul, Minnesota
Frank Enfield, University of Minnesota, St. Paul, Minnesota
D. Reimer, University of Minnesota, St. Paul, Minnesota
W. E. Rempel, University of Minnesota, St. Paul, Minnesota
Alva E. Flower, Montana State College, Bozeman
Joseph J. Urick, North Montana Branch Station, Havre, Montana
C. O. Gardner, University of Nebraska, Lincoln, Nebraska
Lloyd Wiggan, University of Nebraska, Lincoln, Nebraska
Lavon Sumption, University of Nebraska, Lincoln, Nebraska

H. A. Stewart, North Carolina State College, Raleigh, North Carolina
C. A. Pratt, Oklahoma State University, Stillwater, Oklahoma
A. E. Darlow, Oklahoma State University, Stillwater, Oklahoma
J. C. Hillier, Oklahoma State University, Stillwater, Oklahoma
Wayne Miller, Oklahoma State University, Stillwater, Oklahoma
Frank Baker, Oklahoma State University, Stillwater, Oklahoma
Paul Wuthier, Oklahoma State University, Stillwater, Oklahoma
Charles Christians, Oklhaoma State University, Stillwater, Oklahoma
William J. Costello, Oklahoma State University, Stillwater, Oklahoma
Lowell Walters, Oklahoma State University, Stillwater, Oklahoma
R. L. Hendrickson, Oklahoma State University, Stillwater, Oklahoma
Joe B. Armstrong, Oklahoma State University, Stillwater, Oklahoma
A. B. Nelson, Oklahoma State University, Stillwater, Oklahoma
Irvin L. Omtvedt, Oklahoma State University, Stillwater, Oklahoma
H. H. Pierce, Agriculture Experiment Station, Clemson, South Carolina
J. W. McCarty, South Dakota State College, College Station, S. D.
R. J. Cooper, University of Tennessee, Knoxville, Tennessee
David E. Anderson, University of Texas, Austin, Texas
Ralph Durham, Texas Technological College, Lubbock, Texas
Charles F. Parker, Texas A and M, College Station, Texas
Walter Kruse, Texas A and M, College Station, Texas
K. P. Bovard, Virginia Polytechnic Institute, Blacksburg, Virginia
C. C. Mast, Virginia Polytechnic Institute, Blacksburg, Virginia
R. C. Carter, Virginia Polytechnic Institute, Blacksburg, Virginia
Charles E. Bell, Jr. USDA, Washington, D. C.
Neal First, Universtiy of Wisconsin, Madison, Wisconsin
Paul O. Stratton, University of Wyoming, Laramie, Wyoming
F. K. Kristjannson, Canada Department of Agriculture
N. Binnie, Australia
H. M. Vollrath, University of Hawaii, Honolulu, Hawaii
R. A. Barson, Massey Agriculture College, New Zealand
Geoff Harrington, Cambridge, England

MINUTES
S-10 Executive Committee Meeting
Student Union Building
Oklahoma State University
Stillwater, Oklahoma

The Executive Committe consisting of T. C. Cartwright, M. Koger, W. C. Godley, C. M. Kincaid and R. E. Patterson, S-10 administrative advisor, met in executive session at 7:00 p.m. on July 24, 1960.

The informal meeting of the cmmmittee with Dr. E. J. Warwick and Dr. Martin Burris during the previous evening was reviewed for Dr. Patterson who had not been present.

In a discussion of the program for 1961, the desirability of putting emphasis on a comprehensive review of S-10 contributing projects was considered. Dr. Patterson presented for discussion a suggestion that the Regional Projects might be handled as a specific project with discontinuation of state contributing projects. This would avoid the difficulty of keeping state contributing project outlines confined entirely to objectives of the S-10 Regional Beef Cattle Breeding Project. Pros and Cons of such a procedure were discussed with the matter left in a state of indecision. It was then moved that the executive Committee recommend that next year's program include a review of contributing projects. Passed.

A review of the paper on Growth by Kinkel of Texas was discussed. The feeling expressed was that the review should be made available for distribution. It was suggested that the matter be left with Dr. Kincaid and the Texas group for working out the details of publications.

The Bill before Congress (S. 3570) dealing with treatment of animals on experiments supplied by Federal Funds was discussed. In view of the dangers of this bill, the need for a recommendation from the Executive Committee was indicated. It was recommended that a committee be appointed to study this Bill and prepare a statement for consideration by the S-10 Tehhnical Committee. It was suggested that this statement point out dangers to research from this bill and provide for transmission of this information to the legislators of all states in the region.

The Proposed National Animal Germ Plasm Research Laboratory was discussed. General approval for such a facility was indicated, but no action was taken.

M. Koger

1960 S-10 Technical Committee Meeting
Oklahoma State University
Stillwater, Oklahoma

The Committee met for its annual business meeting at 7:00 a.m. on July 27, 1960 in the Student Union Building with Dr. T. C. Cartwright of Texas presiding. Technical Committeemen present were as follows:

Alabama	T. B. Patterson	Auburn University Auburn, Alabama
Arkansas	Warren Gifford	University of Arkansas Fayetteville, Arkansas
Florida	Marvin Koger	University of Florida Gainesville, Florida
Georgia	W. C. McCormick	Ga. Coastal Plain Expt. Sta. Tifton, Georgia
Kentucky	Niel W. Bradley	University of Kentucky Lexington, Kentucky
Louisiana	R. S. Temple	Louisiana State University Baton Rouge, Louisiana
Maryland	W. W. Green	University of Maryland College Park, Maryland
Mississippi	C. E. Lindley	Mississippi State University State College, Mississippi
North Carolina	J. H. Gregory	North Carolina State College Raleigh, North Carolina
South Carolina	W. C. Godley	South Carolina Expt. Sta. Clemson, South Carolina
Tennessee	Charles S. Hobbs	University of Tennessee Knoxville, Tennessee
Texas	T. C. Cartwright	Texas Agric. Expt. Sta. College Station, Texas
Virginia	J. A. Gaines	V. P. I. Blacksburg, Virginia
West Virginia	Not represented	
Regional Coordinator	C. M. Kincaid	AHRD, ARS, USDA Knoxville, Tennessee
SEDS Representative	Martin J. Burris	SESD, ARS, USDA Washington, D. C.
Administrative Advisor	R. E. Patterson	Texas A and M College College Station, Texas

Other personnel in attendance were:

C. J. Brown and P. R. Noland, University of Ark., Fayetteville, Ark.
F. M. Peacock, Range Cattle Station, Ona, Florida
James F. Hentges, Jr. University of Florida, Gainesville, Florida
B. L. Southwell, Coastal Plains Expt. Sta. Tifton, Georgia
T. M. Clyburn, Ga. Coastal Plains Expt. Sta., Reidsville, Ga.
Walter Neville, Ga. Expt. Station, Experiment, Georgia

J. C. Dollahon, Reata, Inc. Hazlehurst, Georgia
Ralph J. Boulware, Louisiana State Uniersity, Baton Rouge, La.
W. R. Backus, Mississippi State University, State College, Miss.
Lloyd Wiggen, University of Nebraska, Lincoln, Nebraska
H. A. Stewart, North Carolina State College, Raleigh, North Carolina
H. H. Pierce, South Carolina Expt. Sta., Summerville, South Carolina
R. J. Cooper, University of Tennessee, Knoxville, Tennessee
Charles F. Parker, A and M College of Texas, College Station, Texas
Walter Kruse, Substation 23 Texas, McGregor, Texas
R. C. Carter, V. P. I., Blacksburg, Virginia

Dr. J. A. Gaines gave the report of the Committee on Data Collection and Analysis. Analysis of data for adjustment factors for weaning data was discussed as apossible regional effort. Also mentioned were analyses of data from the former dual purpose cattle project at Brooksville, Florida. This work is being done in cooperation with Dr. C. M. Kincaid. Dr. Cartwright appointed as members of this committee for next year: J. A. Gaines, Troy Patterson, C. J. Brown and R. J. Cooper.

The report of the committee on Standardization of Carcass and Meats Studies was given by Dr. Charles Hobbs (copy attached). Motion by Patterson, seconded by Green, to continue this committee was passed. Committee appointed: Charles Hobbs, C. J. Godley, J. H. Gregory, and R. J. Cooper.

Dr. C. J. Brown gave the report on forms for annual reports to S-10 (copy attached). The forms used for the 1960 report were the results of efforts of this committee. General approval of the forms was indicated and acceptance of the report approved.

There was a recess of the business meeting at this point for lunch.

Dr. C. M. Kincaid discussed the ten-year report of the region and expressed satisfaction with the response from the various states. Dr. Martin Burris was credited with most of the work on assembling the Bibliograpy of Publication.

After appointment by Dr. Cartwright of Committees for next year, Dr. Kincaid gave the coordinators report. A request for advice from Dr. Kunkel of Texas regarding publication of a review entitled, "Biochemical and Fundamental Bases of Genetically Variable Growth" was brought up for discussion. A motion was passed recommending that it be published, with arrangements for publication to be worked out by Dr. Kincaid and the Texas Station.

The summary of crossbreeding work done in the region was discussed. Following numerous complimentary remarks of the report presented by the regional coordinator th the joint meeting of the three committees, it was moved by Hobbs and seconded by Temple that a bulletin be published as a regional publication from S-10 with Dr. Kincaid taking the leadership. Motion passed.

Revisions of Contributing project and initiation of new work in the region were discussed by North Carolina, Louisiana, and Florida.

BUSINESS MEETING

It will be noted that a number of business items were disposed of during the regular meeting preceeding the formal business meeting.

Minutes of the previous annual meeting which had been published, along with the meeting of the executive committee which were read by the secretary were approved.

Dr. T. C. Cartwright reviewed the status of the proposed National Animal Germ Plasm Research Laboratory. The statement prepared by the Committee representing the S-10, W-1 and NC-1 Committees was read. Moved by Green, seconded by Patterson that statement be adopted. Motion passed. A copy of the statement is attached.

There was a discussion of Senate bill 3570 on humane treatment of experimental animals. A motion was passed to appoint a committee to investigate said bill and make recommendations deemed appropriate to committee members. The committee appointed was Warren Gifford, Chairman, Charles Hobbs and C. E. Lindley.

The report of the resolutions committee was read and approved. The report of this committee is attached.

W. C. McCormick of Georgia was elected to the executive committee. The executives for next year will be M. Koger, chairman, W. C. Godley, Sec., and W. C. McCormick member at large.

Dr. R. E. Patterson gave the report of the administrative advisor.

Invitations for place of meeting for next year were entertained. Moved by Hobbs, seconded by Lindley that the meeting be held next year at South Carolina. Motion passed unanimously.

The recommendation was brought from the executive committee that next year's program feature a comprehensive review of all contributing projects. Moved by Green, seconded by Godley that recommendation be approved. Motion passed. C. J. Brown brought up the suggestion that in view of recent experiences of various stations that the program in the near future should include a review on artificial insemination techniques.

Meeting adjourned at 3:00 p.m.

Statement of Joint Committee on
National Animal Germ Plasm Research Laboratory

At a joint meeting of the S-10, W-1 and Nc-1 beef cattle breeding committees, consideration was given to a proposal for the establishment of a National Animal Germ Plasm Research Laboratory. The project proposal prepared by a committee representing U. S. D. A. and state experiment station personel calls for basic research on animal germ plasm and permits more effectively attacking important problems already being studied in cooperative breeding projects with farm livestock.

Such problems as maintaining adequate genetic control stocks and studies of genetic adaptability to the extreme ranges of climatic conditions in the United States, can be undertaken adequately only with such a facility.

We therefore strongly endorse the proposed laboratory as being an additional research facility which will undertake new research on important problems and compliment existing programs in an active and effective manner.

T. C. Cartwright

Report of Resolutions Committee

Be it resolved that the members of the S-10 Technical Committee express their appreciation to Mr. B. L. Southwell for his council, guidance and inspiration during the period he served as a member of this committee.

Be it further resolved that the Technical Committee express appreciation to Oklahoma State University and specifically to the Experiment Station staff for their kindness, hospitality and use of their facilities during the joint meeting with W-1 and NC-1. Also that our gratitude be expressed to the members of the USDA, ARS, Animal Husbandry Section Beef Cattle Division and the staff of the El Reno Station for the fine tour of this facility.

Respectfully submitted,

W. C. Godley

R. S. Temple

Warren Gifford, Chairman

Report on Committee on Data Collection

Texas and Virginia have undertaken a joint study of private farm beef cattle data to reach a conclusion as to whether the same set of adjustment factors can be applied to Angus and Hereford calves in both states. The data have been collected, and are now being analyzed.

Other states interested in joining in a study similar to paragraph 1 above should write the regional coordinator for the data card format to be used.

The regional coordinator will function to complete a study of individual feeding records using data from Florida, personnel from Tennessee, and personnel and data processing facilities from Virginia.

J. A. Gaines, Chairman

C. E. Lindley

M. W. Bradley

T. B. Patterson

Committee Report on Forms for Annual Report

Through conversation and correspondence this committee evloved the set of record forms which was used by you in preparing this annual report. The intent was to shorten and simplify where possible but yet retain the information that would be useful to describe and compare different groups of cattle. It is recognized that this set of forms is not expected to cover all situations or that all stations will have data appropriate for all these forms. They are offered for your consideration. In order to get discussion, if any, I move their acceptance.

C. J. Brown, Chairman

Marvin Koger

R. S. Temple

C. M. Kincaid

Report of the Committee on Carcass and Beef Standardization

I. Institutions with limited meat facilities
   A. Live animal evaluation
      1. Subjective scores for type,*grade, condition, meatiness, etc.
      2. Objective live animal measurements and the use of such devices as ultra-sonics, etc.
      3. *Accurate and standard off-feed weight and kill weight, with a standard pre-slaughter shrink (24 hours).

   B. Data to be collected at a cooperative packing plant
      1. *Hot and chilled carcass weight (where only hot weight is available then shrink carcass weight 2½% for yield to get a standard chilled carcass weight).
      2. Carcass measurements as outlined in the proceedings of:
         (1) Fourth Annual Reciprocal Meat Conference, pp 89-94, 1951.
         (2) Sixth Annual Reciprocal Meat Conference, pp 73-79, 1953.

         From National Livestock and Meat Board and others as they are improved. This would include a minimum of *"rib-eye" tracing, *fat thickness, and *body length.
      3. *Carcass Grade (U.S.D.A. grade and/or carcass committee grade if possible). Include conformation, maturity, degree of marbling, along with final grade.
      4. *Subjective marbling score based on the 12 descriptive adjectives from the U.S. D. A. beef grading standards.
         Extreme abundant, Very abundant, Medium abundant, Slight abundant, Moderate, Modest, Small amount, Slight amount, Traces, Practically devoid or Devoid.
         An illustrated chart can be otained from AMS of U.S.D.A.

   C. Purchase of one complete wholesale rib for the following analysis: rib should be broken into the 12th rib section, the 9-10-11 rib section and 6-7-8 rib section according to Hankins and Howe, (U.S.D.A. Tech. Bul. 926.) Record aging time and temperature during aging period.
      1. 12th Rib Section - use as a broiled steak for shear strength and taste panel scores or the excised longissimus dorsi could be used for either extract as an objective measure of marbling.[a]
      2. 9-10-11 Rib Section - use for physical separation, chemical analysis and specific gravity.
      3. 6-7-8 Rib Section - use as an oven roast for taste panel scoring, cooking losses and shear strength.

II. Institutions with moderate facilities
   The following is suggested in addition to the suggestion of Section I:

[a]Due to limited facilities, personnel and/or funds - the researcher may desire to obtain only the 12th rib section for analysis. The use of this rather small section would probably limit the data to shear test (highly essential) and palatability studies.

*These should be taken if at all possible.

A. Slaugher animals in experiment station abattoir, according to the procedure outlined in the 4th Annual R. M. C. proceedin s.
B. Break carcass into wholesale cuts according to procedure outlined in the 6th Annual R. M. C. proceedings.
C. More detailed carcass information such as -
   1. Specific gravity of a part or whole carcass.
   2. More complete physical separation.
   3. More controlled and varied taste panel data.
D. With the coöperation of allied departments - other techniques may be attempted such as:
   1. Color determinations.
   2. Histological studies.
   3. Bacteriological studies.
   4. More complete chemical determination.
   5. Bone hardness studies.
   6. Etc.
E. Possible consumer preference studies with either a taste panel and/or cooperating families.

III. Institutions with more complete meat laboratory facilities.

In addition to Sections I and II, the following are suggested:

A. Greater emphasis on chemical determination.
B. Use of isotopes in many ways.
   1. Deposition, metabolism and assimilation.
   2. To assay food additives.
   3. Fasting effects on carcass.
   4. To determine activity of autolytic enzymes.
C. More complete correlation of the live animal to carcass and organoleptic qualities; e.g., live animal biopsy techinques.
D. Use of small animal laboratories for nutritional studies.
E. More detailed consumer preference and information research.
F. Exploratory research; e.g., development of further objective measures of eating quality.

There is a definite need for standardizing the collection of certain data where regional comparisons are to be made.

1. Pre-slaughter treatment
   This would include an accurate off-feed weight and standardized 24 hour shrink before slaughter. This is based on the fact that the G. I. tract of different breed of cattle account for varying amounts of their live weight. The British breeds will usually have approximatel 12% of their live weight made up of G.I. tract, whereas Brahman may have only 10%, Holsteins 14% and Jerseys 16% G.I. tract based on live weight after a 24 hour pre-slaugher shrink.
2. Where palatability tests are to be made, a standardized aging period is necessary. Research data show that maximum tenderness difference should be observed from meat samples which have only been aged 2 or 3 days. However, since most meat the housewife buys will usually have about 7 days age before being consumed, a standardized one week period may be desirable.
3. Since shearing strength as measured by the Warner-Bratzler shear has proven to be quite useful in determining consumer preference - a standard size of core would be desirable. The one-inch core is probably to be preferred over the one-half inch core.

C. S. Hobbs, Chairman
W. C. Godley
J. H. Gregory
H. E. Kidder

EVIDENCE ON HETEROSIS IN COMPARISONS OF CLOSED AND OUTBRED CATTLE GROUPS IN W-1

H. H. Stonaker

The basic material for heterosis studies is, of course, closed non-interbreeding populations which may be drawn upon for crossing. The scope of material available for crossing in the Western Region is considerable, for Dr. Clark as indicated to me that in 1959 there were 65 closed lines of cattle incorporating 1623 breeding cows in the herds of the 12 western stations. In most instances, these lines have been formed by necessity in selection experiments. In fewer instances, lines have been formed more as a basis for studying inbreeding and crossing effects. Nevertheless, regardless of the principle reasons for establishing the closed lines, when crossing in some form takes place, there is opportunity to get some information on heterosis. This survey of the topic is made possible through the generosity of the technical committee members in W-1. In most instances the data have been released in progress reports or in private correspondence. Results are not far enough along to justify the refinement of statistical analysis in many cases. In others, an appreciable amount of data have been accumulated and level of significance noted. When the reports from the several stations are appraised, however, it seems there are trends at this time which are indicative of a general parallelism between results in beef cattle and in other animals and plants.

Table 1 is a 2 x 2 table in which inbred, outbred, linecross, and crossbred cattle may be compared in all possible combinations. I was pleasantly surprised to note how many of these cells had at least some information in them, and in time, will have much more. Missing, for at least the immediate future, is the incorporation of linecrossbred cattle into these comparisons. Theoretically, these should display more heterosis than any combinations presently being tested. In Table 1 ratios are presented in which the production of the more inbred group os the numerator and the less inbred is the denominator. The minus signs indicate a lower level of performance for the inbreds, plus signs indicate inbreds out produced less inbred or crossbred cattle. Level of inbreeding has not been reported, but for most groups it woudl be from about 12% up to 30 to 40 per cent. Controls are outbreds at the same station or in some cases, such as at Havre, refer to the purchase of "reputation" cattle from nearby ranches. Linecrosses will have at least one parent from a closed line, the other most generally will be an outbred or a linecross of the same breed. Crossbreds are breed crosses between outbred parents, the sire will be of one breed, the dam from another breed, or, in some cases, as at Miles City and Ft. Lewis the dam will be crossbred. The data in Table 1 are arranged in order of expected difference in the comparison due to degree of inbreeding and width of cross. Thus the difference between inbreds and outbreds would be expected to be less than the difference between inbreds and linecrosses. Reference sources are indicated by the letters adjoining the ratios and may be found in the appendix to Table 1.

TABLE 1. SUMMARY OF W-1 EXPERIMENTS ON CROSSING BEEF CATTLE - 1960 (H. H. Stonaker)

	Inbred vs:		Control vs:		Linecrosses vs:
	Direction of Effects:	Ratios	Direction of Effects:	Ratios	
Control:					
Stillbirths	-	1.50Ma**			
Daily gain	+ -	1.08H, .97Fb			
Feed/gain	-	1.03Fb			
Linecrosses:					
Semen grade	-	.79Fa	-	(Birth wt) .92Md	
Calf crop	-	.86Fb	-	.78Fb	
Weaning wt.	+ - -	1.10Cb, .92Ca, .92Fb	+ - -	1.04S, .95Md, .92Fb	
Daily gain	- - 0	.91Cb, .81Ca, 1.00Fb	- - -	.890, .88H, 195Md, .94FB	
Feed/gain	- - +	1.13Cb, 1.14Ca, .95Fb	0	1.00Fb	
Crossbred:					
Birth wt.			-	.94Mb	
Wean. wt.		*	- -	.83Mc, .92Mb	
Daily gain		*	- -	.96Mc, .88Mb	
Feed/gain		*	+	.93Mc	*
Rig composition			0	1.00Mb	*
Shear value			-	1.02Mb	*
Tenderness			+	.98Mb	
Flavor			0	1.00Mb	
Grade			-	.94Mc	

*Data Forthcoming **References in table appendix

Appendix to Table 1.

M - Miles City a) Stillbirths - a comparison of all lines with test herd An. Sci. 18(1:85-90)

b) Charolais - Hereford crosses W-1 Report 1960

c) Circular 810 on 3 breed crosses. Table 3 1946-47 only used because of limited observations earlier.

d) Top cross tests 1959 W-1 Report

F - Ft. Lewis a) Inbred vs. linecross yearling bulls. (Proc. W. Sect., 1958)

b) Current summaries unpublished inbreds and linecrosses by same sires.

C - Univ. of California Current summaries 1960 W-1 report on crossing of Rover and Brae Arden lines only Rover Cows or Brae Arden x Rover Cows.
(a) Brae Arden ♂ x Rover ♀
(b) Rover ♂ x BA - Rover ♀

H. Havre Current summaries of comparisons of M.C. Line 1 with Havre crosses with purchased reputation cattle from the area. (W-1 Report, 1960)

S - San Carlos Summary - Pahnish correspondence (1960) Miles City inbred performance selected sires vs. San Carlos visually selected sires.

O - Codding - Armour 112 day progress report on gains of progeny groups. Sires from lines at Ft. Lewis and Miles City as well as outbred sires from various herds. (Leaflet, Codding Armour Research, 1960)

Comparisons of crosses at Mississippi cut across regional lines results Mississippi reports.

Rate of stillbirths in the inbred Line 1 cattle at Miles City has not been high in themselves, but, compared with the outbred cattle there, the difference has been strikingly in favor of the less inbred cattle. Daily gain of steers from closed lines at Havre has exceeded the gains of "reputation" cattle purchased in the area for comparison, while at Ft. Lewis the differences have been only slight between more closely inbred yearling bulls and an outbred control group. At Ft. Lewis the same inbred bulls have taken a slightly greater amount of feed to make their gain. Inbred bulls at Ft. Lewis have been particularly inferior to linecross paternal sibs from these same lines in the grade of their semen at 13 to 15 months of age. This difference primarily has been in morphology. In calf crop again the inbreds have been markedly lower than the linecrosses by the same inbred sires. Calf crop here is measured as $\frac{\text{Numbered weaned}}{\text{Number cows exposed}}$. At California, claves from inbred Rover cows have exceeded the weaning weights of backcross calves; although dams' ages haere would not be the same and there is but one year's data available. Linecross calves from inbred Rover calves have been heavier than their contemporary inbred calves from the Rover line. At Ft. Lewis summaries on several hundreds of inbred and linecross calves indicate lower weaning weights for inbreds. California inbred bulls of the Rover line gained less and had greater feed/gain ratios than did linecross bulls, but at Ft. Lewis gains have been similar for inbreds and linecrosses with inbreds being slightly more efficient.

In the California trials bulls are fed to a finish constant, whereas in Colorado the tests were on a 140-day basis. This may explain the differences in results. Presently, no data are available for comparing inbreds or linecrosses with crossbreds, but a small group of crossbred Angus-Shorthorn cows are being bred each year to a different outbred Hereford bull at Ft. Lewis. It is hoped that these three breed crosses may provide additional evidence on heterosis per se and on the performance of rotational linecross Herefords versus 3 breed crosses. Current crossbreeding at Miles City also should make crossbred vs. linecross vs. inbred comparisons possible.

The cattle classified as outbred control here vary in source. Some are outbred cattle kept as something of a control by the station. In other cases they are purchased as calves for feed test comparisons. At Miles City the linecross calves sired by Miles City lines have had approximately an 8% greater birth rate than control or outbred cattle. At Ft. Lewis the calf crop from control outbred groups has been considerably less than that from the linecross group. Actually at Ft. Lewis this group has produced smaller calf crops than even existed in the inbreds. In weaning weights, the linecrosses have generally exceeded the control population both at Ft. Lewis and at Miles City. At the San Carlos reservation the linecross Miles City calves were not as heavy at weaning as the control outbreds there. The control cattle have not gained as as rapidly as the linecrosses at Ft. Lewis, at Miles City, Havre or in the Codding-Armour feeding tests. At Ft. Lewis there has been no difference in the feed per unit of gain in the comparison of outbreds versus linecrosses. Again at Ft. Lewis it is a bit disturbing that there is not more parallelism between daily gain and feed requirements per

unit of gain on these outbred and linecross groups. This may be due to different composition of gain in the groups being compared and serve to suggest feeding to a constant body composition. The comparisons of crossbreds versus controls are exclusively based upon Miles City data. Here there are two types of observations available- those indicated by (b) are the results of recent Charolais-Hereford crosses, in which crosses and both parent breeds were compared concurrently. In birth weight the average of the pure breeds was less than that of the crossbreds. Similar differences were found in weaning weight and daily gain. In the composition of the rib cut, shear value and tenderness only small differences have been observed between the crossbred Hereford-Charolais and the mean of the parent breeds. In the earlier three-breed-cross work at Miles City the same general picture prevailed in that weaning weight and daily gain were less for the Hereford than the crosses. However, feed requirement per unit of gain was less for the Hereford than for the crossbreds. Here again is an incosistency between feed requirement per unit of gain and in the gaining ability of the animals involved.

It will be a matter of interest to find if line crosses within a breed may be compared in production with three-breed-crosses, using the breeds without the formation of inbred lines. Results on this should soon be forthcoming.

As indicated earlier there apparently are no experiments designed at this time to compare linecrossbreds with other forms of hybrids to see if this gives a further amount of heterosis.

From this preliminary review of the results of experiments in progress it seems apparent without question that the prevailing picture indicates some degree of heterosis when less inbred stocks are compared with more inbred stocks. In 26 comparisons the more inbred produced less than the cross or less inbred cattle. In 4 trials there was no difference between the more inbred and the less inbred, and in only 6 trials did the more inbred outproduce the less inbred. Degree of heterosis varies with the trait. The most stricking differences appear to be in those traits having to do with viability and with reproduction-traits such as stillbirths, quality of semen and calf crop. Appreciable amounts of heterosis appear present in weaning weights. Varying results have been found in daily gain, but again for the most part some heterosis is indicated. Unfortunately the experimental evidence varies as to feed efficiency and in some studies notably those at Ft. Lewis and Miles City the difference of feed efficiency has not been in the same direction as daily gain. That is, the faster gaining cattle groups actually in these cases have been the less efficient. However, in the California studies there has been a parallelism between daily gain and feed per unit of gain. The different procedure there of using a finish constant basis for determining length of trial rather than a time length, possibly points out an explanation of the disappointing and unexpected results obtained in feed efficiency at Miles City and at Ft. Lewis.

When traits for which heritabilities are fairly well established are sorted according to their level, a high, medium and low, a pattern

of heterosis behavior seems apparent. This organization of the data from Table 1 is presented in Table 2. For traits with high heritabilities such as daily gain and feed per unit of gain, 12 trials indicated that the more inbred stocks produced less than the less inbred stocks. There was no difference in 2 trials, and three in which the more inbred stocks actually exceeded the less inbred stocks. For medium heritability traits, weaning weight and birth weight, in 7 trials the more inbred cattle produced less than the crosses, and in 2 trials the more inbred produced more than the crosses. For traits with low heritability, such as calf crop and stillbirths, the inbreds produced less than the crosses in all three comparisons reported. Sampling errors on much of these data must still be high, but it looks as if there were an inverse relationship between degree of heterosis and the heritability of traits. For traits with low heritabilities some system of hybridizing may be well necessary. The evidence at this time indicates that along with selection programs in beef cattle, mating systems which provide opportunities to exploit heterosis will be needed.

Table 2. Summary from Table 1 of direction of effects of inbreeding on beef traits having high, medium and low heritabilities.

	Number of experimental comparisons		
	- Effect	0 Effect	+ Effect
High h^2			
Daily gain	9	1	2
Feed/gain	3	1	1
	12	2	3
Medium h^2			
Birth wt.	1	0	0
Wean. wt.	6	0	2
	7	0	2
Low h^2			
Stillbirths	1	0	0
Calf Crop	2	0	0
	3	0	0

INBREEDING AND HETEROSIS IN BEEF CATTLE

NC-1

C. A. Dinkel

At the time of the initiation of NC-1, projects involving inbreeding, or at least with major emphasis on inbreeding as the mating system, far outnumbered any others. Practically all contributing projects involved inbreeding in one way or another, and many included a study of inbreeding effects as a major objective. During the growth of NC-1 there has been a change in emphasis until at the present time inbreeding is included in most new projects or project revisions only as a necessity rather than as a primary objective. There seems to be two reasons for this change. First, it is difficult to visualize the large scale adoption of this breeding system by the cattle industry. Second, the high estimates of heritability already obtained which indicate that selection should be effective in improving the economically important traits of beef cattle. When corn research was at a comparable stage, most workers doubted that the practical application of inbreeding could be successful. When the corn lines were at the 20 to 40 per cent level I doubt that hybrid corn companies had entered anyone's mind. The outlook for the use of inbred lines in practical beef cattle production would appear to be better now than at the time NC-1 was formed. The trends towards larger operations, fewer family farms, and the increased interest in artificial insemination, all seem aimed in the direction that would mean easier utilization of lines. In addition, reasons for using inbreeding other than that of producing highly inbred lines are fully as important as the production of such lines.

Reasons for Inbreeding

Among the reasons for inbreeding that have been or could be listed are the following:

1. To produce lines that will be superior in their own performance.
2. To produce lines that will be superior in crosses with other lines.
3. To obtain information on inbreeding effects.
4. To obtain information on heterosis.
5. To obtain reliable estimates of the effectiveness of selection.
6. To study methods of producing superior animals.
7. To obtain information on gene action.

These items are by no means mutually exclusive, and very likely a project involving inbreeding would include more than one of these as objectives.

I doubt that my purpose is to discuss each one of these individually, especially to this audience. Each one of us, no doubt, has his own convictions as to which is the most important, and I doubt that we would be unanimous in a vote on any one of these. Some points that might be worthy of further discussion could be mentioned.

One of these is the matter of a control group for measuring the effects of inbreeding and for evaluating the mating system. Probably it is more important for the latter, although it might also be equally important for the first. Some work I did at Iowa with their Poland China inbred lines indicated that the average of all crosses of the lines within the breed recovered over and above the inbred lines only what could be expected on an additive basis. Crosses of lines from different breeds were not included in this study and the results might have been quite different had they been included. If the crosses of our inbred lines of beef will recover only what has been lost through inbreeding, then it is doubtful that the mating system would have any practical value. This overlooks the possibility of obtaining one or a few outstanding single crosses which might be well worth the formation of the lines. A control line would allow a direct measure of this, and would enable an evaluation of the single and top crosses as they are produced. Some of us in the region have felt the need for a control group originating from the same germ plasm as the inbred lines but maintained at a much lower level of inbreeding and subjected to approximately the same selection pressure. At South Dakota we have just produced our first line-cross calves this spring. Thus, all we have available are birth weights on sixteen calves. These calves were sired by a bull that was 38% inbred and the single cross calves were from dams with an average inbreeding coefficient of 17%. The birth weights indicate a seven per cent advantage of the single cross over the average of the inbred lines, but only a 1 to 2 per cent advantage over the controls. These data are not offered as research results but only as one example of the use of a control line.

The control line could be useful also in evaluating the inbred lines as top-cross parents. Inbred lines of beef cattle will probably have their greatest usefulness in topcrosses, since the levels of inbreeding which can be attained in a reasonable period of time, the length of generation interval, the high cost of individual replacements, and the reproductive rate in beef cattle all appear to favor the use of inbred lines in top-crosses as opposed to their use in single crosses. The benefits of top-crossing do not include the expression of heterosis, but rather the benefits are derived from the testing of many lines and the selection of those lines high in general combining ability based on their topcross performance. Partial utilization of heterosis might be achieved in a topcrossing program through the rotation of sires from inbred lines which have demonstrated high specific combining ability.

Another point that might be worthy of discussion is the matter of the sampling error involved in those projects concerned with intense inbreeding. There is some doubt in my mind that we have satisfactorily evaluated intense inbreeding sufficiently to merit dropping as many of these projects as we have. It is true there are still three projects in the region concerned with intense inbreeding and possibly with cooperation with stations in the other regions that are doing similar work, suitable evaluation can be achieved. One wonders though, when comparison is made of the number of inbred lines of corn that are evaluated before the elite hybrid is obtained, with the number of lines of cattle that are being formed in the entire region, just what our chances are in this regard. The question here is,

what is the probability of truly evaluating the levels of heterosis possible in beef cattle? Do we stand a chance of finding the elite lines and crosses with the present number of lines? Perhaps this is evidence for greater use of reciprocal recurrent selection.

I do not think these questions of size are peculiar only to the stations involved with intense inbreeding. Somewhat the same questions might be asked by those concerned with evaluating selection and particularly evaluating genetic correlations by single trait selection. Possibly the basic question here, from a regional standpoint, is whether we should concentrate on one of the two areas and obtain a satisfactory answer or can we expect on the basis of present projects to answer both of the questions simultaneously?

Problems Involved with Inbreeding Projects

At the present levels of inbreeding in most projects we have probably not encountered all the problems we will be forced to meet, and probably the problems we have encountered will become more severe as the level of inbreeding increases. Any project involving a closed line will require maintaining more reserve bulls than would be necessary on an outbred basis. At South Dakota we have made a practice of keeping two bulls for each of out one-sire lines and we have occasionally come up short with this number.

Fertility problems are usually encountered in inbreeding projects and some have experienced this in the North Central Region. Thus far, at the present levels of inbreeding we have not had extreme difficulty in this regard in the South Dakota herds.

We have experienced the depressing effect of inbreeding on milk production and this is particularly troublesome with young heifers. I believe this has been a general problem in all projects where inbreeding coefficients of 20% or more are common.

The matter of recessive defects appearing in the lines may also be a problem. How severe the problem is may depend upon the objectives of the experiment. For example, if the objective is to produce superior lines, lines should be culled with the appearance of a serious defect provided an accurate means of eliminating the carriers is not available. On the other hand, if the objective of the experiment is to determine methods of producing superior animals or to obtain information on inbreeding effects or heterosis, the occurrence of a defect need not eliminate the line.

Problems of data analysis may be the most troublesome and difficult to solve, particularly in the case of one-sire lines. There are numerous opportunities for confounding of sources of variation that have already been recognized and probably there are some that have not been foreseen. Among those already encountered are confounding of year and sire, sire and pasture, age of dam and inbreeding of dam, sire and line, and pasture and line. Some of these

problems may be overcome by a least squares solution after several year's data have been collected as was pointed out by Dr. R. M. Koch at one of our earlier meetings. The better estimates of heritability, genetic correlations, and environmental adjustments, will probably come from data other than those collected from one-sire inbred lines. Most states have sources of such data, either collected in the field by their extension services or in another phase of the breeding project. Data collected from the one-sire lines will probably be most useful in obtaining information relative to the seven objectives listed earlier. Those closed lines involving more than one sire should not be as subject to the analysis problems as are the one-sire lines. Better estimates of heritability, genetic correlations, and inbreeding effects should be available in a fewer number of years from these multiple sire lines. However, this is counterbalanced in the case of estimating inbreeding effects by the slow rate of increase of inbreeding.

NC-1 Projects Concerned with Inbreeding and Heterosis

For purposes of discussion, I have divided the projects into three classifications. They are those involved with intense inbreeding, the heterosis projects, and those projects involved with the use of closed lines for the evaluation of selection methods. I hope that individual project leaders will feel free to correct any errors that I may commit in reporting their projects, and to fill in any details concerning their projects that they wish to. Practically all station projects include objectives other than those concerned with inbreeding studies. In view of the assigned topic these objectives were omitted from the following discussion.

Those states with projects involving intense inbreeding are Iowa, Kansas, Nebraska, and South Dakota. The Iowa project calls for two Angus, two Hereford, and one Shorthorn line. The inbreeding of the calves in the 1958 calf crop averaged by line from 7 to 19 per cent. One Angus line has recently been outcrossed, and a new Angus line was established in 1959. Due to low fertility, the Shorthorn line was re-established in 1959. The Iowa project plan calls for approximately one sire and ten females per line, and two of the five lines have been performing satisfactorily at the levels of inbreeding attained. Three of these lines have produced dwarfs, each being a different hereditary type.

The Kansas project calls for the establishment of two Shorthorn lines with inbreeding to progress as rapidly as possible. The average inbreeding of the calves in the two lines in 1958 was 5 and 15 per cent. This may not be entirely indicative of the inbreeding practiced, since the 1957 calf crop had levels of 22 and 13 per cent. These lines are maintained at approximately 20 and 40 cows per line with 2 bulls being used per line.

The Nebraska station has studied the effects of inbreeding in small closed lines. A shift has occurred in their work recently and many of these lines have been discarded as small one-sire lines and worked into a new program

which will be covered in a following section. Only one line in the 1958 calf crop produced inbred calves and these calves averaged 9 per cent.

The South Dakota project calls for maintaining five one-sire lines of 15 to 20 cows each, and a four-sire control line of approximately 60 cows. Inbreeding levels in the one-sire lines averaged from 6 to 28 per cent in the 1958 calf crop.

All of these projects collect complete performance records including feed efficiency with the exception of the South Dakota and Nebraska projects. Individual feeding was terminated in 1958 at South Dakota, and Nebraska now collects individual consumption on samples of the closed-line selection experiment. All of these projects list as an objective a study of the effects of inbreeding on beef cattle. In addition, many of the lines being formed will be used to estimate the importance of heterosis for the several economically important traits in beef cattle.

The Ohio and Nebraska stations have projects designed to measure the amount of heterosis obtained in crosses of different breeds of beef cattle. The Ohio station is using the Hereford and Charolaise breeds, and is developing the calves under two different management regimes. Under the first, the calves will be creep fed, fattened, and slaughtered at 12 to 14 months of age. The second system involves no creep feeding, wintering, grazing, fattening in the dry lot with slaughter at 18 to 20 months of age. This plan provides an estimate of the genetic-environmental interaction. The project plan calls for approximately equal numbers of Hereford, Charolaise and crossbred cattle to be produced the first three years. Calves will be split to the two management systems listed. All except heifer calves necessary for replacement will be slaughtered. In the following three years, all heifers will be retained to replace the original cow herd and to furnish cows for the study of the influence of heterosis upon cow performance traits. Straight bred and crossbred cows will be bred to bulls of a third breed. This project was initiated in 1959 and first matings were made in that year.

The Nebraska project will involve the Angus, Hereford, and Shorthorn breeds and will be carried out at the Fort Robinson Station. The plan calls for 240 cows, 80 of each breed, to be mated according to the plan in Table 1.

Table 1. Mating System for Phase 1.*

Females (all grades)	Angus Line				Hereford Line				Shorthorn Line				
	1		2		1		2		1		2		
	Bulls		Bulls		Bulls		Bulls		Bulls		Bulls		
	1	2	1	2	1	2	1	2	1	2	1	2	
Angus	10	10	10	10	5	5	5	5	5	5	5	5	80
Hereford	5	5	5	5	10	10	10	10	5	5	5	5	80
Shorthorn	5	5	5	5	5	5	5	5	10	10	10	10	80
	20	20	20	20	20	20	20	20	20	20	20	20	240
	40		40		40		40		40		40		240
	80				80				80				240

*Furnished by Dr. R. M. Koch, University of Nebraska

The project was initiated in 1957 with the purchase of the grade calves, and these heifers were bred as two year olds in 1959. Actual numbers bred in 1959 were 276 heifers, 92 of each breed, with 12 breeding groups being utilized to provide intra and interbreed cross-combinations of the three breeds. Four bulls of each breed were used with one pair of bulls of each breed being inbred and the other pair non-inbred. This system will be repeated for three years to complete the first phase of the experiment.

Several stations have projects which are primarily concerned with selection but which necessitate closed lines for achieving the goals set forth. Illinois has three closed lines of approximately 40 cows each with three bulls being used per line. One line is selected for fast gaining ability, the second line is selected for early fattening ability, and the third line is a random-bred control group.

Indiana has one four-sire closed line of 80 cows. The cows are assigned to two groups permanently. One of these groups has creep feeders available during the suckling period whereas the other group does not. The creep versus non-creep treatments are balanced to the sires affording an evaluation of this management practice. One-half of the bull calves from each sire are castrated at the end of the calving period and one-half are left as bulls. All calves are fed out and all are slaughtered except those needed for replacements.

The Iowa station has 70 cows on the Albia farm which are divided into three lines. One line is bred to production bred bulls from Experiment Station herds, a second is bred to purebred bulls of conventional breeding, and the third line is a closed line with replacements being selected from within the line on the basis of their performance.

The Missouri station has a selection study involving two four-sire closed lines of 100 cows each. One line is selected on yearling weight (12 month) and the second on an index based on yearling weight and conformation score. All traits will be measured in both lines providing an estimate of the genetic correlations between the selected traits and the unselected traits.

The Nebraska station has a selection study involving three six-sire lines of 150 cows each. One line is to be selected on weaning weight alone, the second on yearling weight (18 month) alone, and the third on yearling weight plus conformation score. All traits will be measured in all lines enabling a measure of the genetic correlations between the selected traits and the unselected traits.

The Oklahoma station has maintained four lines under an improvement program based on selection and mild inbreeding. These lines are approximately 30 to 40 cows each. The level of inbreeding in one of these lines in the 1958 calf crop averaged 11 per cent. The last report from the Oklahoma station indicates that this project is up for revision with the possibility of considerable change in objectives and procedures.

NC-1 Results from Inbreeding and Heterosis Projects

Results available in NC-1 are primarily estimates of inbreeding effects on most of the economically important traits and some estimates of the level of heterosis from the Ohio crossbreeding study.

Least squares estimates of inbreeding effects were obtained in two studies of the South Dakota data. Zoellner fitted constants for a year-line-ranch classification and for an inbreeding classification. The data studied were the weaning weights, 18 month weights, and conformation scores of 143 heifers raised at three substations during the period 1953 to 1955. The inbreeding levels ranged from zero to 25% and were divided into 6 classes for the analysis. Inbreeding effects were significant at the .05 level for weaning weight and non-significant for 18 month weight and conformation score. Table 3 contains the estimates obtained and the number of animals in each inbreeding classification.

Table 3. Estimates of Inbreeding Effects on Weaning Weight, 18-Month Weight, and Conformation Score.*

Percent Inbreeding	Number Animals	Weaning Weight	18-Month Weight	18-Month Conformation Score
0	25	0	0	0
1 - 5	19	-22.77	-23.30	0.27
6 - 10	39	-38.56	-28.44	0.26
11 - 15	36	-33.86	-25.89	-0.20
16 - 20	12	-43.40	-55.55	-1.01
21 - 25	12	-52.66	-56.62	-0.85

*Furnished by K. O. Zoellner, South Dakota State College

The coding system for the conformation scores gave a value of 17 to the highest possible score and a value of zero to the lowest score. The regression of weaning weight on inbreeding of the individual in these data was -1.76 pounds per one per cent inbreeding.

Dearborn analyzed the R. O. P. data collected on 224 bull calves fed individually for 196 days postweaning in the years 1953 through 1958. Constants were fitted for each of the following classifications: Sire, Year, Inbreeding of the individual, and Ranch. The inbreeding levels varied from zero to 38% and were divided into seven classes for the analysis. The characteristics studied and the estimates obtained are shown in Table 4.

Table 4.
Estimates of Inbreeding Effects on Daily Gain, Final Weight and Final Conformation Score*

Percent F	No. of Animals	140 Day Daily Gain	140 Day Final Wt.	168 Day Daily Gain	168 Day Final Wt.	196 Day Daily Gain	196 Day Final Wt.	196 Day Final Conformation
0 - 5	106	0	0	0	0	0	0	0
6 - 10	47	-.0361	+ 5.06	-.0146	+ 8.54	+.0468	17.04	-.8502
11 - 15	30	-.1134	- 43.81	-.1031	- 45.41	-.0643	- 40.36	-.9571
16 - 20	18	-.0516	- 25.43	-.0318	- 23.16	+.0072	- 17.76	-1.0077
21 - 25	10	-.1069	-104.61	-.1440	-112.83	-.0601	-101-64	-1.8555
26 - 30	5	-.1264	- 92.53	-.1359	- 96.49	-.1307	-101.95	-2.6846
31+	8	-.2645	-234.36	-.2552	-240.01	-.1608	-233.54	-4.0310

*Furnished by D. D. Dearborn, South Dakota State College.

The positive estimates for all three final weights in the 6-10% classification were not anticipated. The corresponding estimates for rate of gain for the three periods indicate that most of this curvilinear effect must have been present at weaning although Zoellner's results in the heifer analysis did not indicate this. It appears that inbreeding affected the bulls more severely than the heifers in both final weight and conformation score; however, this difference may be entirely due to sampling error.

Several regression analyses conducted in the region afford further estimates of inbreeding effects. Dr. L. A. Swiger of the Regional Coordinator's office has analyzed the Nebraska data from the Lincoln and Fort Robinson herds for the years 1951 to 1956.

Table 5. Summary of Inbreeding Effects*

Lincoln				Fort Robinson	
			Birth Weight		
	All lines		Lines 1,2,3	All lines	
F_{calf}	-.38		-.45	-.06	
F_{dam}	-.03		-.10	+.13	
			Preweaning ADG		
F_{calf}	-.0052		-.0051	+.000046	
F_{dam}	-.0006		-.0032	-.00046	
			200 Day Weaning Weight		
F_{calf}	-1.47		-1.47	-.05	
F_{dam}	-.15		-.74	+.04	
			168 Day Feedlot Gain		
F_{calf}	-1.26	±.6		-.55	±.3
F_{dam}	-.93	±.5		.58	±.3
Age on test	-.36	±.3		.006	±.1
			168 Day Consumption (TDN)		
F_{calf}	-3.49	±2.3		-.42	±1.2
F_{dam}	-2.85	±1.8		3.35	±1.3
Age on test	3.05	±1.2		2.06	± .4

*Furnished by Dr. L. A. Swiger, Beef Cattle Research Branch, A.R.S., U.S.D.A.

The partial regressions (Table 5) are in pounds per one per cent inbreeding, and the regressions for post-weaning gain and consumption were computed simultaneously with age on test. The regressions for the pre-weaning traits were computed from within line-age of dam-year subclass sums of squares and cross products after adjusting for sex. The regressions for the post-weaning traits were computed from within sire-line-year-sex subclass sums of squares and crossproducts. The length of the post weaning test was 168 days. Dr. Swiger has indicated more faith in the Lincoln estimates than in the Fort Robinson estimates, because of the higher levels of inbreeding in the Lincoln data.

Dr. L. N. Hazel has calculated the regression of weaning weight on inbreeding of the calf in the Iowa data and obtained a value of -3.6 pounds per one per cent inbreeding. This estimate is based on 140 calves, 30 of which were Hereford, 15 Shorthorn and the remainder Angus.

Birkett Howarth obtained estimates of the effect of inbreeding on weaning weight, 12 month weight and conformation score. He analyzed the data taken from 285 heifers over an eight year period in the South Dakota project. The regressions were calculated from within year-sire subclasses after the weight characteristics had been adjusted for age and age of dam. His estimate of the regression of weaning weight on the inbreeding of the individual was -1.99 pounds per one per cent inbreeding. The estimated regression of 12 month weight on inbreeding of the individual was -2.23 pounds per one per cent inbreeding, and the conformation score estimate was -.04 units per one per cent inbreeding. The units here are as given before, ranging from 0 to 17 for low to high conformation score, respectively. Inbreeding effects were significant at the .01 level for weaning weight and 12 months weight and at the .05 level for conformation score.

Another study of the ROP bull data at South Dakota presently being conducted yields the following estimates of the regression of feed required per hundred pounds of gain on inbreeding of the individual:

140 day feed/cwt gain = 0.84 $\pm$ .76 pounds/1% inbreeding
168 day feed/cwt gain = 1.18 $\pm$1.37 pounds/1% inbreeding
196 day feed/cwt gain = 1.70 $\pm$ .89 pounds/1% inbreeding

These estimates were calculated on a within year-sire subclass basis and initial weight differences were held constant by the use of covariance. There were six year's data involving 171 calves. The inbreeding effects were non-significant for the three periods.

Estimates available from all stations for the regression of weaning weight on inbreeding of the individual vary from -0.05 to -3.60 with four of the six estimates falling in the range of -1.42 to -1.99 pounds per one per cent inbreeding. There are only two independent estimates among these four coefficients since the data used in calculating one of the estimates is included in the second estimate in both the Nebraska and South Dakota analyses.

It is difficult to compare the remaining estimates from the different stations because of differences in methods of calculation. The Nebraska estimates for feed lot gain are regression coefficients of total gain on inbreeding whereas the South Dakota estimates are least squares estimates for daily gain. The feed consumption analyses are different also with Nebraska analyzing total TDN for the post-weaning period, and South Dakota using feed per hundred pounds of gain. The Nebraska estimates are the only estimates independent of the inbreeding of the dam.

In general, these results seem to be comparable to the results found in inbreeding experiments with swine and dairy cattle. Efficiency of feed

utilization seems to be affected very little by inbreeding. Growth rate appears to be affected somewhat more, but still not to the extent that the inbred animals are severely handicapped. Litter size in swine is one of the characteristics most seriously affected by inbreeding, although considerable variation among lines has been reported (W. A. Craft, 1953, U.S.D.A. Circ. No. 916). Line differences in fertility have been demonstrated in beef cattle at the Nebraska Station, and during the period the inbred lines were maintained at Fort Robinson fertility appeared to decrease with inbreeding. Perhaps fertility problems in lines at other stations will become more severe as the level of inbreeding increases and this characteristic may also parallel the swine results. If present estimates of inbreeding effects are reasonably accurate, it should be possible to carry present inbred lines to substantially higher levels of inbreeding.

The only results available in NC-1 concerning the levels of heterosis present in beef cattle come from the Ohio crossbreeding project (Gerlaugh et. al. Ohio Research Bulletin 703). Dr. Keith Gregory has recalculated part of the data presented in this bulletin to show the comparison of the crosses with the means of the parental breeds (Table 6).

Table 6. Summary of Weights, Gains, Feed Efficiency and Carcass Quality Comparing Crosses with Means of Parental Breeds*

	No.	Parental Means (Hereford-Angus)	No.	Means of Crosses
Birth wt. (lbs.)	205	64	196	64
Adj. Wn. Wt.	188	356	186	372
Av. daily gain birth to wn.	188	1.58	186	1.66
Av. daily gain on pasture last 4 yrs. only, 150 days	85	1.01	92	1.02
Feedlot Performance:				
Av. daily gain	187	1.64	186	1.68
T.D.N. per cwt. gain (lbs.)	187	634	186	636
Dressing percentage	180	60.0	185	60.6
Carcass Grades:				
Choice		125		135
Good		53		49
Commercial		2		1

*Data recalculated from Ohio Research Bulletin 703 by Dr. Keith Gregory.

No test of these differences has been made but there appears to be evidence for heterosis in weaning weight, gain from birth to weaning, and carcass grade. Dr. John Lasley recalculated the data concerned with survival to weaning from this same project. This analysis indicated that 94.9% of the crossbreds survived to weaning whereas only 91.7% of the purebreds lived to that age. He also estimated 6.5% heterosis in number of animals reaching the choice carcass grade. Considering survival to weaning, weaning weight, and carcass grade the crossbreds maintained an advantage over the purebreds of about 5%, and they were essentially equal to the purebreds in the other traits presented in Table 6.

Since heterosis is dependent in part upon homozygosity and especially homozygosity at different loci for the parent breeds or lines being crossed, one might expect the levels of heterosis found in crosses of breeds to be less than that obtained from crosses of moderately or highly inbred lines. This should be true if the inbred lines are not closely related and the lines are formed from the same breeds used in the crossbreeding procedure. I doubt that this generalization would necessarily hold in the case where crosses of Brahman x Hereford or any other wide cross were being used to predict levels of heterosis to be expected in crosses of lines within the Hereford breed. Perhaps some of the swine breeders present can give us the benefit of their experiences with the performance of Landrace crossbreds in comparison to crosses of inbred lines both within and between breeds. It seems to me that if we are predicting from crossbreeding results the levels of heterosis to be expected in crosses of inbred lines we must be careful to specify the population for which our prediction will hold. This, I believe, is comparable to the fact that an estimate of specific combining ability is good only for the particular lines involved in the estimate. Further, the failure to demonstrate heterosis in breed crosses does not rule out the possibility of heterosis occurring in crosses of inbred lines formed from these breeds, although the probability of its occurrence would appear to be less.

Summary

There are indications that heterosis might be important in beef cattle. At least sufficiently so that we should proceed with efforts to establish the level attainable with inbred lines. Whether or not the level of heterosis is sufficiently large to be practically important and whether or not heterosis can be utilized in practical beef production, the inbreeding projects can be justified on the basis of the information provided on inbreeding effects, effectiveness of selection, and gene action. Estimates of inbreeding effects presently available indicate that:

1. Feed efficiency is only slightly affected by increases in inbreeding.

2. Growth is affected somewhat more than feed efficiency but still not to the point that inbred animals are severely handicapped.

3. Higher levels of inbreeding should be attainable in the present inbred lines.

The foregoing might indicate that I am convinced of the benefits to be gained from inbreeding beef cattle. This is far from the truth since I am uncertain regarding the usefulness of inbred lines in top crosses on commercial herds, uncertain regarding the possible levels of heterosis in beef cattle, and highly uncertain regarding practical ways of utilizing heterosis if it should be of an important magnitude. My reasons for continuing a project involving intense inbreeding, other than the seven objectives listed earlier, might be listed as follows:

1. Our regional project and out state project have listed since their initiation an objective dealing with a study of the effects of inbreeding and the magnitude of heterosis in beef cattle. This objective deserved thorough study before it is dropped by all stations.

2. If it were not for inbreeding, we would not have our present day breeds.

3. If it were not for inbreeding, breeders would not have been able to reduce the frequency of the dwarf gene to the extent that has been achieved.

4. If it were not for inbreeding, many herds would not have influenced their respective breeds to the extent that they have in the past.

5. Although I am uncertain as to the possibilities of higher levels of inbreeding becoming practically useful, I am certain that our beef industry is changing and will change more in the future. When industry asks us whether or not inbreeding has a place in the changing industry, I hope that we will have progressed far enough to give them an answer.

Dr. Oliver Willham (Jour. Hered. 1937:28:283) stated the need very clearly when he said, "We are still much in the dark about how rapid a rate of inbreeding can be guided safely by selection. Yet the thought persists that it may have been a needless waste of time to take 70 years to do work which might possibly (?) have been done as well in 20 or 30 years." While Dr. Willham was referring to lower levels of inbreeding than we are considering today, with the present predictions for increased needs for beef in the future we may well have to do 70 years work in 20. If intense inbreeding proves to be a method of accomplishing this, industry will find a way of utilizing it in a practical manner.

Breed Crosses with Beef Cattle in the Southern Region

S-10

C. M. Kincaid

Adaptation to unfavorable environmental conditions for beef production in the southern part of the country, particularly in the Gulf Coast area, has been a major problem. The crossing of breeds as a means of achieving adaptation and improving production has received much attention in beef cattle breeding investigations in that area for the last three decades. One of the major objectives of the S-10 Regional Project on beef cattle improvement through breeding methods has been to investigate crossbreeding with beef cattle. Several experiments on crossbreeding have been initiated since the S-10 project was started in 1948 and the results from many of these experiments have been reported in the literature. In order to bring these data together in one study that would throw light on the general aspects of crossbreeding for the southern region, the S-10 Technical Committee instructed the Coordinator to obtain and summarize the data from the various experiments at different locations in the project. This report is an attempt to bring together data collected in several experiments in the S-10 project on breed crosses with beef cattle. In bringing these data together, the primary point of view has been to obtain general indications regarding the value of crosses among different breeds and types of cattle used primarily for beef production in the South.

SOURCE OF DATA AND METHODS

The experiment stations that provided data, the location and the scope of each set of matings is shown in table 1. Each of the ten sets of matings included groups that were part of the same experiment at one station or location. In all, some ten different breeds of bulls and fifteen different breeds of cows were used to produce 53 different matings (breed combinations) in 82 subclasses. For this study a mating was determined by the breed of the sire and the breed of the dam. All 82 subclasses in table 1 provided observations on growth rate from birth to weaning but only part of them were represented for other characteristics. Subclass means were the primary or basic observations. Subsequent tables of means and estimates of variances were computed by operating on these means and averages of them.

With ten breeds of sires and fifteen breeds of dams a complete table of all possible matings would have 150 cells. With a maximum of 53 matings, it is obvious that there are many missing values. To bring the observations to somewhat the same basis for comparisons across all matings, it was necessary to first obtain estimates of the mean of each mating within location and then adjust for the average effect of location. In some cases the data had been adjusted by fitting constants within location and

Table 1. Breeding of Sires and Dams in Sets of Matings at Different Locations

Station	No. of Matings	No. of Progeny	Breeds Represented Sire	Dam
Alabama (Black Belt S.S.)	6	254	Angus Hereford	Hereford Short-Herf Brah-Herf
Florida (Ona)	7	804	Shorthorn Brahman	Shorthorn Brah-Short 1/4Brah-3/4Short Brahman
Florida (Belle Glade)	8	730	Devon Brah-Devon Brahman	Devon Brah-Devon Brahman
Georgia (Tifton)	6	144	Angus Hereford Shorthorn Brahman	Hereford Ang-Herf Brah-Herf
Georgia (Reidsville)	12	951	Angus Hereford Shorthorn Santa Gert Brahman	Angus Hereford Ang-Herf Brah-Herf Brah-Native Brahman
Georgia (Alapaha)	2	352	Shorthorn	Hereford Brah-Native
Louisiana (Baton Rouge)	24	597	Angus Hereford Shorthorn Brah-Ang Brahman Charolais	Angus Hereford Brah-Ang Brahman
South Carolina (Clemson)	6	310	Angus Hereford Brahman	Angus Hereford
South Carolina (Summerville)	4	167	Shorthorn	Angus Ang-Herf Brah-Ang Brah-Herf
Texas (McGregor)	7	1494	Hereford Brah-Herf Brahman	Hereford Brah-Herf 3/4Brah-1/4Herf Brahman
Total - 10 sets (53 different)	82	5803	10	15

then adjust for the average effect of location. In some cases the data had been adjusted by fitting constants within locations. These adjusted means were tabulated as reported. Where no adjustment had been made, the procedure was to obtain weighted mean differences within location between one mating designated as a control[1] and all others in that experiment. The weighting factor for each paired comparison in this study was obtained with the equation

$$(1)\ W = \frac{n_1\ n_2}{n_1 + n_2}$$

where n_1 was the number of animals in the control group and n_2 was the number of animals in the other group. The difference (d) was the difference between the two means. Weighted average differences (d_i) were the adjustments for their respective means, where

$$(2)\ \bar{d}_i = \frac{\Sigma w_i d_i}{\Sigma w_i}$$

Average differences among stations were estimated from weighted differences between all possible pairs of stations within each mating to obtain a relative average difference for each station. These relative average differences were equated to zero to obtain the adjustment to be added to the means in each experimental set. The means thus obtained were the primary observations for study.

The breeds that went into the matings were classified into four main categories; referred to hereafter as types. These types were (B) British, (BZ) crosses between British and Brahman, (Z) Brahman, and (C) Charolais. All four types were represented at least once by sires but only the first three by dams.

RESULTS

Birth Weights

Observations on birth weights were obtained from 35 different matings representing seven breeds of sires and eight breeds of dams. The number of stations or locations, the number of calves and the average birth

(1) This was usually the straight Hereford; but, where it was absent another British type was used.

weights by mating are shown in table 2. The mean square obtained from differences within matings was 16.95 with 20 degrees of freedom. From this the standard deviation of means of matings with 1, 2, and 4 observations would be approximately 4, 3, and 2 pounds, respectively.

The general picture from the data in table 2 is that Brahman dams tend to have the lightest calves. Angus dams with Angus calves behaved somewhat like the Brahmans, but, there was a strong suggestion of interaction of Angus dams with other breeds, particularly the Brahman and Charolais. Brahman-Angus matings at three different locations all gave values that were above the average for the table.

The values for British x British matings suggest a slight amount of heterosis for Angus x Hereford but this could easily result from chance. Calves with Hereford and Shorthorn breeding tend to be heavier than those with Angus breeding, but no marked heterosis is evident for crosses among British breeds.

The means by mating type (table 3) and the analysis of variance of these means (table 4) indicate real differences for both main effects (sires and dams) and heterosis for Brahman;British crosses. British and crossbred types of dams had values not greatly different but their calves were almost ten pounds heavier than those from Brahman dams. For sire, the British and crossbred types were close together while calves sired by Brahman bulls were about four pounds heavier. Calves sired by Charolais bulls were consistently heavier than those sired by the other three types, with the average difference amounting to 8.1 pounds per calf.

The data very definitely indicate heterosis for birth weight in crosses between the British and Brahman types with type-crosses approximately six pounds heavier. Brahman-British calves out of the British dams were about ten pounds heavier than they were when the dams were Brahman. There was no indication of interaction of the Charolais with the other types. Calves sired by Charolais bulls followed the same general pattern across the different types of dams as those sired by bulls of the other types.

Growth Rate from Birth to Weaning

Since the age at weaning was variable from station to station, average daily gain, rather than weaning weight, was used as a measure of growth during the suckling period. Average daily gain from birth to weaning was obtained by subtracting the birth weight from the weaning weight and dividing by the age at weaning. Where birth weight was not available weaning weight was divided by age at weaning plus 40. This assumed that on the average a calf would gain an amount equal to his birth weight in 40 days.

The number of locations, number of calves and adjusted means for daily gain from birth to weaning with type of mating by breed of sire and dam

Table 2. Mean birth weights by matings with number of stations and number of calves in each mating[1]

SIRES	DAMS Angus	Herf.	Ang-Herf.	Short-Herf.	Brah-Angus	Brah-Herf.	Brah-Native	Brahman	Total and Average
Angus	3 218 59.7	5 360 61.7		1 38 66.0	1 28 64.0	1 67 63.0	1 24 56.0	1 29 58.0	13/7 764 60.5
Hereford	2 76 68.3	4 373 66.6		1 23 68.0	1 30 70.0	1 46 64.0	1 23 66.0	1 29 67.0	11/7 600 67.1
Shorthorn	2 73 60.7	1 21 72.0	3 91 65.0		1 68 64.2	 77 64.2		1 23 66.0	12/6 353 65.4
Brah-Angus	1 19 70.0	1 21 72.0			1 24 68.0			1 22 58.0	4/4 86 65.7
Santa Gert.	1 36 65.0	1 81 73.0					1 34 65.0		3/3 151 67.0
Brahman	3 227 73.5	3 101 73.7			1 28 74.0			1 23 58.0	8/4 379 68.5
Charolais	1 25 73.0	1 23 81.0			1 29 77.0			1 24 68.0	4/4 101 74.0
Total and Average	12/7 674 67.2	17/7 980 71.4	3/1 91 65.0	2/2 106 67.0	7/6 207 69.5	5/3 190 63.7	3/3 81 62.3	6/6 150 62.5	55/35 2434 66.5

(1) For each mating the top figure is the number of stations, the middle figure the total number of calves and the bottom figure the average birth weight adjusted for station differences within mating. In the marginal summary an expression for such as 13/7 indicates the number of observations and number of different matings.

Table 3. Average birth weights by type of mating with number of matings and number of calves in each type of mating[1]

Type of Sire	Type of Dam: British	Type of Dam: Brit x Brah Cross	Type of Dam: Brahman	Total and Average
British	9 1273 65.3 ± 1.3	8 363 63.9 ± 1.4	3 81 63.7 ± 2.3	20 1717 64.[illegible]
Brit x Brah Cross	4 157 70.0 ± 2.0	2 58 66.5 ± 2.8	1 22 58.0 ± 3.9	7 237 64.8
Brahman	2 328 73.6 ± 2.8	1 28 74.0 ± 3.9	1 23 58.0 ± 3.9	4 379 68.5
Charolais	2 48 77.0 ± 2.8	1 29 77.0 ± 3.9	1 25 58.0 ± 3.9	[illegible] 101 74.0
Totals and Average	17 1806 71.5	12 478 70.4	[illegible] 150 61.9	35 2434 67.9

(1) In each cell top figures show number of matings, middle figure the number of calves and bottom figure the average of mating averages.

Table 4. Analysis of variance of birth weight by type of sire and dam

Source of Variation	df	M. S.
Dams	1	182.40**
D_1 Brit vs Brah	1	182.40**
D_2 Brit and Brah vs cross	1	35.53
Sires		
S_1 Brit vs Brah	1	26.88
S_2 Brit and Brah vs cross	1	5.01
S_3 Charolais vs others	1	148.03
Interactions		
$S_1 \times D_1$	1	49.00
Others	5	[illegible].25
Error[1]		

(1) Error mean square = $\frac{15.53}{2.70}$ = 5.75, where 15.53 was the mean square for differences among matings within type and 2.70 was the coefficient for the component within type obtained from the formula $N_o = \Sigma n - \frac{\Sigma n^2}{\Sigma n}$.

is shown in table 5. Seven of the twelve main classes have three or more matings in them. Observations in the other five cells are somewhat scanty and, therefore, subject to larger sampling errors. Analysis of variance of matings within type and observations within matings turned out as follows:

Source of variation	Degrees of Freedom	Mean Square
Among matings within type	41	.0126
Within means of matings	29	.0097

The mean square for differences among observations within matings was .0148, which with $k_0 = 1.53$ gave the above estimate of average variance of means within type. There was considerable variability among means within types of matings, but there did not appear to be any clear cut pattern associated with heterosis among matings within type of mating.

The picture is somewhat different when the data are considered on the basis of average daily gain among the means of different types of matings (table 6). The analysis of variance of the means in table 6 are shown in table 7. Five of the eleven degrees of freedom relating to differences among mating types accounted for over 90% of the total variance.

The average overall difference between British and Brahman dams was small and favored the Brahman by .04 of a pound per day Brahman-British (cross-type) dams were superior to both the British and Brahman types across three of the four types of sires. The overall average favored the cross-type by about 1/10 of a pound per day approximately 20 pounds at weaning). The main effects for type of sire showed relatively small average differences among the British and Brahman and their crosses, but, calves sired by Charolais bulls grew faster for two of the three kinds of dams. On the average, calves sired by Charolais bulls gained almost 1/10 of a pound per day more.

Heterosis in crosses between Brahman and British is indicated by the interaction S_1D_1. Crossbred calves excelled over the straightbred calves by approximately 1/6 of a pound per head per day. This would amount to about 35 pounds at 200 days of age. The data also suggest (S_2L_1 interaction) that Brahman British calves on British dams grew faster than British calves on British dams. It was surprising that crossbred calves had less limitation imposed on their growth rate in the suckling period than British dams either insisted on and got more milk, or stole from their neighbors, or rustled more for feed in addition to milk, or were more efficient. On the other hand, the straight Brahman calves had relatively slow growth rates and caused Brahman dams with Brahman calves to appear lower in mothering ability than they really were. As will be seen later, straight Brahmans had growth rates after weaning similar to their preweaning gains. British x British and Brahman x Brahman calves grew slower to weaning than any of the crosses of these two types.

Kincaid (8)

Table 5. Number of Stations, Number of Calves and Adjusted Means for Daily Gain from Birth to Weaning of Calves by Breed of Sire and Dam Within Type of Mating

Type of Mating	Sire	Dam	Number of Stations	Number of Calves	Average Daily Gain (Adjusted)
British x British	Angus	Angus	3	241	1.67
	Hereford	Angus	2	76	1.80
	Shorthorn	Angus	2	73	1.64
	Angus	Hereford	5	355	1.70
	Hereford	Hereford	5	824	1.68
	Shorthorn	Hereford	2	151	1.52
	Shorthorn	Shorthorn	1	47	1.43
	Devon	Devon	1	380	1.69
	Hereford	Ang-Herf(F_1)	1	15	1.54
	Shorthorn	Ang-Herf(F_1)	3	74	1.65
	Angus	Sh-Herf(F_1)	1	38	1.73
	Hereford	Sh-Herf(F_1)	1	23	1.82
	Total or average		27/12	2297	1.67
British x Brahman	Angus	Brahman	1	29	1.79
	Hereford	Brahman	1	29	1.98
	Shorthorn	Brahman	2	210	1.84
	Devon	Brahman	1	12	1.84
	Total or average		4/4	280	1.86
Brahman x British	Brahman	Angus	3	120	1.85
	Brahman	Hereford	5	701	1.79
	Brahman	Devon	1	96	1.91
	Total or average		9/3	917	1.85
Brahman x Brahman	Brahman	Brahman	4/1	393	1.69
	Brahman	Brahman	4/1	393	1.69
British x Cross	Shorthorn	Brah-Ang(F_1)	1	44	1.98
	Angus	Brah-Ang(1)	1	28	1.78
	Hereford	Brah-Ang(1)	1	30	1.92
	Shorthorn	Brah-Ang(1)	1	24	1.84
	Angus	Brah-Herf	1	67	1.92
	Hereford	Brah-Herf	3	173	1.97
	Shorthorn	Brah-Herf	3	63	1.89
	Shorthorn	Brah-Short	1	122	1.98
	Devon	Brah-Devon	1	54	1.92
	Angus	Brah-Native	1	24	2.07
	Hereford	Brah-Native	1	23	2.06
	Shorthorn	Brah-Native	1	222	1.80
	Shorthorn	1/4Brah-3/4Short	1	35	1.75
	Total or average		17/13	909	1.92

Table 5 (Cont.).

Type of Mating	Sire	Dam	Number of Stations	Number of Calves	Average Daily Gain (Adjusted)
Brahman x Cross	Brahman	Brah-Ang(1)	1	28	1.86
	Brahman	Brah-Herf	1	162	2.08
	Brahman	Brah-Short	1	165	2.04
	Brahman	Brah-Devon	1	51	1.84
	Brahman	3/4Brah-1/4Short	1	107	1.85
	Brahman	3/4Brah-1/4Herf	1	26	1.92
	Total or average		6/6	539	1.93
Cross x British	Brah-Ang(1)	Angus	1	19	2.10
	Santa Gert.	Angus	1	36	1.95
	Brah-Ang(1)	Hereford	1	21	1.66
	Brah-Herf	Hereford	1	45	1.91
	Santa Gert.	Hereford	1	81	1.85
	Brah-Devon	Devon	1	20	1.94
	Total or average		6/6	222	1.90
Cross x Brahman	Brah-Ang(1)	Brahman	1	22	1.75
Cross x Cross	Brah-Ang(1)	Brah-Ang(1)	1	24	1.78
	Brah-Devon	Brah-Devon	1	65	1.80
	Santa Gert.	Brah-Native	1	34	2.11
	Total or average		3	123	1.90
Charolais x Other	Charolais	Angus	1	25	1.78
	Charolais	Hereford	1	23	1.73
	Total or average		2/1	48	1.76
	Charolais	Brah-Ang	1	29	1.98
	Charolais	Brahman	1	24	2.04
	Total or average		4/3	101	1.93
	Grand Total		82/53	5803	1.86

(1)Brahman-Angus designated as (1) were a line that had been developed from cross and bred "inter se" for at least two or three generations.

The Charolais crosses were all at one station. It is interesting to note that calves sired by Charolais bulls gained much faster on Brahman dams than they did on British dams. The large value for the interaction S_3D_1 emphasizes the failure of the two kinds of dams to respond to different types of sires in the same way.

On the whole, suckling gain appeared to be largely a function of the milk production of the dam, provided she had a calf with enough growth potential to stimulate maximum production. It seems that good milk production in the dam or supplemental feeding of calves is necessary in the suckling period for preweaning gain to provide a useful estimate of growth potential in the calf.

Postweaning Gain

Data on postweaning gains were obtained from three stations: Tifton, Georgia; Baton Rouge, Louisiana; and McGregor, Texas. The data from Georgia included two kinds of crossbred heifers (Angus x Hereford and Brahman x Hereford) fed 140 days after weaning. The data from Louisiana were on steers produced by mating six breeds of bulls to four breeds of cows over a five year period with all 24 combinations represented. The postweaning test was for 140 days on full feed. The bulls and the heifers were each fed the same kind of ration in different years over the period from 1952 to 1958. The ration for steers was similar from year to year, but in some years the steer groups were split and fed rations with contrasting ratios of roughage to concentrate. With the exception of a few steers on winter pasture, the ration was a mixture of ground forage and concentrate self-fed to all groups.

Gains in both the pretest period (birth to start of test) and the test period were converted to average daily gain. This avoided difficulties from differences in average age at the start of the test and differences in the length of the test periods. It also put measurement of growth on a similar basis for preweaning and postweaning periods.

It was apparent in the data from both Louisiana and Texas that rank on gain in the pretest and test period showed big changes for the majority of the matings. The variance among matings of pretest gains at the Louisiana station was much smaller than the variance of test gains and the relation between the two periods was negative. Except for the straight Brahman, which was low in both periods, the relative rank in the two periods tended to reverse. The same sort of thing was observed in the Texas data. Variance among matings was much larger in the test period for all three sexes but the relation was positive. However, when the straight Brahmans (lowest in both periods for all three sexes) were not included the relation between the two periods was negative for the bulls and steers and near zero for the heifers.

It was apparent that compensatory gain was a factor that greatly influenced the test gain of certain matings. In some cases test gains seemed

Table 6. Means for daily gain by type of mating with number of matings and number of calves in each type of mating

S I R E S	D A M S			Total and Average
	British	Cross	Brahman	
British	27/12 2297 1.67	17/13 909 1.92	5/4 280 1.86	49/29 3486 1.82
Cross	6/6 222 1.93	3/3 123 1.90	1/1 22 1.75	10/10 367 1.86
Brahman	9/3 917 1.85	6/6 539 1.93	4/1 393 1.69	19/10 1849 1.82
Charolais	2/2 48 1.76	1/1 29 1.98	1/1 24 2.04	4/4 101 1.93
Total and Average	44/23 3484 1.80	27/23 1600 1.93	11/7 719 1.84	82/53 5803 1.86

Table 7. Analysis of variance of means in table 6 by type of sire and dam

Source of Variation	Degrees of Freedom	Mean Square
Sires		
S_1 British vs Brahman	1	.0001
S_2 Brit and Brah vs crosses	1	.0032
S_3 Charolais vs others	1	.0196
Dams		
D_1 British vs Brahman	1	.0021
D_2 Brit and Brah vs crosses	1	.0345
Interactions		
S_1D_1	1	.0306
S_2D_1	1	.0127
S_3D_1	1	.0408
Other interaction	3	.0018
Error(1)	41	.0031

(1) Error mean square obtained by dividing variance among means within type (.0126) by $k_o = \Sigma k - \Sigma k^2 / \Sigma k = 4.09$.

to be influenced so much by the gain prior to the start of the test that test gains were almost meaningless as a measure of real growth potential. To at least water down and in some measure control part of the influence of compensatory gain, gain per day of age from birth to the end of the test was used to measure overall potential for growth.

The 24 different matings in the Louisiana data were all contemporary over a five year period and no adjustment was made for year. Both matings at the Tifton, Georgia, station were represented in all three years and year effect was ignored. In the Texas data, matings were missing in some years and feeding methods. Weighted average differences within year and ration were obtained and the means adjusted to a within year and ration basis. The bulls were combined with the steers by adjusting for the average differences between bulls and steers within mating. The bulls outgained the steers by an average of .15 of a pound per day of age.

Gains per day of age by matings are shown for the three stations in tables 8 and 9. The analysis of variance (table 8) of the Baton Rouge data indicate that much of the variation associated with dam in the pretest and test periods tended to disappear when life-time gain was used. On the basis of lifetime gain, the Charolais bulls sired calves with the fastest average growth rate. Shorthorn and Hereford sires had calves that grew faster than Angus sires while, on the average, the Brahman sires were similar to the Hereford and Shorthorn and the Brahman-Angus similar to the Angus.

The interaction mean square indicates differential effects among the different sires and dams. Matings among the British breeds show little evidence of heterosis. Angus and Hereford crosses actually were lower, on the average, than the straight breds. Crosses between Brahman and Brahman-Angus favored the crosses over straight breds but the average positive difference here was about the same size as the negative difference for the British matings. The interaction mean square with one degree of freedom representing heterosis for crosses among Brahman and British types (British sires x British dams and Brahman sires x Brahman dams versus British sires x Brahman dams and Brahman sires x British dams) was .1080 in contrast to .0031 for the residual with thirteen degrees of freedom. It is rather clear that there was heterosis from crossing Brahman and British types with the average difference amounting to .15 of a pound per day. At 450 days of age this would be about 70 pounds. The interaction (S_5D_3) also indicates that type of dam influenced the results with Charolais bulls. Here straight Brahman dams had calves with the slowest average growth rate. This is in contrast to preweaning data where Charolais crosses from Brahman dams were highest.

The McGregor, Texas, data showed relatively large differences among matings and a large effect for sex, but the two sexes behaved more or less alike across the seven matings. Here there is evidence of heterosis in crosses between the Hereford and Brahman.

The data from Baton Rouge and McGregor were put together (table 10) to illustrate the behavior of gain per day of age as the ratio of British to

Table 8. Gain per day of age from birth to end of test by steers in different matings at Baton Rouge, Louisiana

SIRES		DAMS Angus	Hereford	Brahman-Angus	Brahman	Total and Average
Angus	No.	10	11	10	18	49
	GDA	1.55	1.40	1.63	1.62	1.55
Hereford	No.	11	11	12	13	47
	GDA	1.51	1.58	1.66	1.75	1.62
Shorthorn	No.	16	12	14	8	50
	GDA	1.55	1.55	1.72	1.69	1.63
Brahman-Angus	No.	9	11	10	13	43
	GDA	1.48	1.64	1.52	1.49	1.53
Brahman	No.	11	11	10	10	42
	GDA	1.74	1.72	1.60	1.39	1.61
Charolais	No.	10	11	15	8	44
	GDA	1.66	1.71	1.66	1.62	1.66
Total and Average		67	67	71	70	275
		1.58	1.60	1.63	1.59	1.60

Analysis of Variance of Louisiana Means

Source of Variation	Degrees of Freedom	Mean Square
Sires		
S_1 Angus vs Hereford	1	.0112
S_2 Ang and Herf vs Shorthorn	1	.0043
S_3 Brahman vs Brah-Angus	1	.0128
S_4 British vs Brah and Brah-Angus	1	.0038
S_5 Charolais vs others	1	.0178
Dams		
D_1 Angus vs Hereford	1	.0010
D_2 Brahman vs Brah-Angus	1	.0044
D_3 British vs Brah and Brah-Angus	1	.0028
Interactions		
S_4D_3	1	.1080
S_5D_3	1	.0320
Other interactions	13	.0031

Table 9. Gain per day of age from birth to end of test by steers and heifers in matings at McGregor, Texas and Tifton, Georgia

SIRE	DAM	Steers and Bulls McGregor, Texas		HEIFERS McGregor, Texas		HEIFERS Tifton, Georgia	
		No.	GDA	No.	GDA	No.	GDA
Angus	Hereford					24	1.80
Hereford	Hereford	516	1.71	356	1.53		
Hereford	Brah-Herf	35	1.82	58	1.67		
Brah-Herf	Hereford	23	1.75	15	1.64	19	1.83
Brahman	Hereford	310	1.85	283	1.61		
Brahman	Brah-Herf	76	1.77	76	1.58		
Brahman	3/4Brah-1/4Herf	8	1.74	6	1.52		
Brahman	Brahman	144	1.57	112	1.45		

Analysis of variance of means at McGregor

Source of Variation	df	Mean Square
Matings	6	.0128
Sex	1	.1045
Sex x mating	6	.0012

Table 10. Trend of gain per day of age with fraction of British and Brahman blood by sex and station

FRACTION British	FRACTION Brahman	MALES McGregor No.	MALES McGregor GDA	MALES Baton Rouge No.	MALES Baton Rouge GDA	FEMALES McGregor No.	FEMALES McGregor GDA	Relative Rank[1]
8/8	0/0	516	1.71	71	1.52	356	1.53	1.00
6/8	2/8	58	1.78	56	1.63	73	1.65	1.06
4/8	4/8	310	1.85	71	1.67	283	1.61	1.08
2/8	6/8	76	1.77	23	1.54	76	1.58	1.03
1/8	7/8	8	1.74			6	1.52	1.01
0/0	8/8	144	1.57	10	1.39	112	1.45	93 and station

(1)By getting within sex and station the ratio to the straight British type and weighting these ratios according to the number in each group.

Brahman blood changed. In all three station-sex groups the straight Brahman had the slowest growth rate. The column showing the relative rank indicates a curvilinear trend. The 50-50 combination gave the most rapid gain with the gain dropping off faster as the fraction of blood moved in the direction of the Brahman than it did when the fraction moved in the direction of the British. Twenty-five percent Brahman was almost as good as 50 percent. It appears that backcrosses to the British type tend to hold growth potential much nearer the F_1 than backcrosses to the Brahman. The data also suggest that future work with Brahman-British crosses would do well to more fully explore the trend of performance with successive backcrossing to the British type following original Brahman-British crosses.

Carcass Characteristics

Data on slaughter and carcass traits were obtained from steers produced at three stations: Baton Rouge, Louisiana; McGregor, Texas and Ona, Florida. Feeding methods and breed composition of the different groups at Baton Rouge and McGregor were given in the section on Post-Weaning Gain. Carcass information was obtained on all steers at Baton Rouge and on samples from groups at McGregor. The data from steers from Ona, Florida were obtained in an experimant designed to estimate the influence of different fractions of Shorthorn and Brahman blood on carcass traits. Equal numbers in each breeding group were full fed on the same ration in dry lot 140 days after weaning in four different years.

Since the primary interest in this investigation related to differences among different kinds or types of beef cattle, the breeding groups were classified on the basis of percentage of blood from British beef breeds, from Brahman, and from Charolais. The data were first adjusted by weighted average differences within breed-grop subclasses at each station and teen adjusted for average differences between stations within broad breeding groups. The breeding groups, number of steers at each station and averages for slaughter and carcass traits by breeding groups are shown in Table 11.

For the eight breeding groups, age at slaughter range from 405 to 429 days. The averages for slaughter weight, gain per day of age and carcass weight per day of age follow the same general pattern of growth which was noted in the study of Post-Weaning Gains. The averages for dressing percentage suggest a curvilinear trend as the ratio of British to Brahman blood changes. The straight Brahman group dressed 2.7% more than the straight British, but all three groups representing a mixture of these two were above the straight Brahman. Although the numbers are small, the average dressing percentages for the groups sired by Charolais bulls suggest that this breed may be similar to the British breeds in this respect.

With the exception of area of rib eye all other characteristics in Table 11 indicate linear trends with changes in genetic composition of the groups.

The rib eye area tended to follow slaughter weight but with one notable exception. The Charolais-Brahman group, below the general average in slaughter weight had the largest rib eye of all. Rib eye area per 100 pounds of carcass was somewhat the same for all groups except the Charolais-Brahman cross.

Carcass grade and fat cover at the 12th rib follow the same general pattern. For groups with British and Brahman blood carcass grade and fatness decline as the percentage of British blood declines. The data also suggest that the Charolais may carry less fat cover and grade lower than the Brahman. Composition (by physical separation) of the 9-10-11 rib show trends for percent fat, lean and bone that parallel (approximately) the trend for carcass grade and fat thickness over the 12th rib. The ratios lean to bone and fat to bone were included as possible indicators of relative muscling and fatness in terms of general body frame work. On the basis of lean to bone ratio, it appears that the Charolais may have more muscling and the Brahman less than the average of the British breeds. The ratio of fat to bone decreased as the British blood decreased and alos suggested that the Charolais had less fat in proportion to general body size than the Brahman.

Warner-Bratzler shear force values by percentage of British and Brahman blood increased as the percentage of Brahman blood increased. It appears that tenderness as it relates eating quality is a factor that should be taken into account in evaluating the usefulness of the Brahman as a breed and in crosses for commercial beef production. Shear force values for progenies sired by Charolais bulls were similar to those sired by British bulls. Charolais-British crosses gave values similar to straight British while Charolais-Brahman crosses were similar to British-Brahman crosses.

BREEDING GROUPS BY PERCENTAGE OF BLOOD, NUMBER OF STEERS AND AVERAGES FOR CERTAIN CARCASS CHARACTERISTICS AFTER ADJUSTMENT FOR DIFFERENCES WITHIN AND AMONG THREE STATIONS

KIND OF BREEDING	BREEDING GROUPS BY PERCENTAGE OF BLOOD							
British	100	75	50	25	00	50	25	00
Brahman	00	25	50	75	100	00	25	50
Charolais	00	25	00	00	00	50	50	50
STATION	NUMBER AT EACH STATION BY BREEDING GROUP							
Baton Rouge, La.	71	56	71	23	10	21	15	8
McGregor, Tex.	80		92	35	10			
Ona, Florida		15	16	16	16			
Total 3 Stations	151	71	177	74	36	21	15	8
CHARACTERISTIC	ADJUSTED AVERAGE BY BREEDING GROUP							
Age (days)	429	413	422	416	405	429	417	405
Slaughter wt. (lbs.)	755	786	810	754	673	838	804	765
Gain per day of age	1.61	1.72	1.75	1.65	1.51	1.79	1.76	1.70
Carcass weight per day of age	1.03	1.13	1.15	1.09	.98	1.15	1.12	1.12
Dressing percentage	57.2	59.4	60.1	60.2	59.1	58.9	58.6	60.2
Carcass grade(1)	11.1	10.7	10.2	9.4	8.4	9.3	8.0	7.7
Fat cover at 12th rib (mm)(2)	11.1	10.0	9.9	7.7	4.6	9.0	6.0	5.5
9-10-11 rib cut								
% fat	30.6	30.4	28.5	25.2	20.6	26.2	20.4	17.5
% lean	52.1	52.1	53.7	55.3	58.3	56.0	59.8	62.2
% bone	17.3	17.5	17.8	19.5	21.1	17.8	19.8	20.3
Lean/bone	3.01	2.97	3.02	2.84	2.76	3.14	3.02	3.06
Fat/bone	1.77	1.74	1.60	1.29	.98	1.47	1.03	.86
Rib eye area (sq.in.)(2)	8.48	8.72	8.90	8.60	7.60	9.20	8.90	9.50
Rib eye area per cwt carcass(2)	1.91	1.87	1.82	1.89	1.90	1.86	1.89	2.08
Warner-Bratzler Shear (lbs. of force)(3)	13.8	14.8	15.6	17.4	20.2	13.6	13.1	15.5

(1) Standard, good and choice had respective values of 7.0, 10.0 and 13.0.

(2) Data from two stations: Baton Rouge, Louisiana and McGregor, Texas.

(3) Adjusted to one inch core. McGregor, Texas and Ona, Florida used 1/2 inch cores. This was adjusted to inch cores by multiplying by the factor 1.55, the average ratio within breeding group of the Texas and Florida values to the Baton Rouge values.

Discussion of Papers on Heterosis and Inbreeding in Beef Cattle

L. N. Hazel

The unique attributes of Mendelian heredity are (1) that inheritance is by particles, and (2) the particles occur in pairs. Studying the performance of inbreds, purebreds, and outcrosses of any animal species is a first step in securing information about what happens when the pairs of particles are alike more frequently than usual or unlike more frequently than usual. From the results of the crossbreeding experiments summarized by Drs.Dinkel, Kincaid, and Stonaker, it is evident that similarity or dissimilarity of parentage has greater immediate effects upon performance than any other genetic change which can be induced in animals in a few generations.

To attempt a comprehensive summary is an effort to evaluate the effects of inbreeding and crossbreeding by drawing generalizations across species, geographic areas, ecological niches, etc. The foregoing evidence on heterosis in beef cattle agrees in several respects with what has been observed in other species. In particular, the degree of within breed heritability and the amount of heterosis found in crosses is inversely related in beef cattle as has been observed in corn, swine, and chickens. The evidence is sufficiently clear to draw the general rule, "Heterosis is greatest for those characteristics which exhibit lowest heritability (in the narrow sense) within breeds. Conversely, heterosis is small or nonexistent for characteristics showing high within breed heritability."

Exceptions to this general rule undoubtedly do, or at least can, occur. For example, if there were no genetic variability at all in a characteristic, either of an additive genetic, dominance or epistatic sort, both heritability and heterosis would be nonexistent.

While present knowledge may not be sufficient to extend much past the formulation of the above conclusion, one is led to speculate concerning the factors responsible. It seems logical that where long-continued selection has been consistently in one direction, as for reproductive ability, that the additively genetic variation within breeds would have been reduced to whatever low limit that method was capable of achieving. Hence, within breed heritability for this trait should be small. This has been verified by a number of experiments, both in beef cattle and in other farm livestock. Because normal reproduction in females is the result of a complex sequential chain of many events, each of which must occur in its proper stage and time, and because success must occur in all of the sequential events, much of the hereditary variation is non-linear. That non-linear hereditary variation is present in measurable and important proportions is evidenced by the higher reproductive rate of crossbred females.

For many characteristics in beef cattle, such as growth rate, feed requirements, skeletal size, etc., selection seems not to have been consistently in one direction for a sufficiently long period of time to have lowered appreciably the genetic variability. For other important characteristics, particularly those relating to relative muscle size, carcass quality,

and tenderness, selection has been practically nonexistent because of the lack of ability to measure directly such traits. These important traits are proving to be highly hereditary. Developing methods of measuring and selecting for the traits is one of the beef cattle scientists' greatest opportunities and challenges.

But heterosis is not an all-or-none thing, either completely present or completely absent for any given trait. The evidence presented previously and evidence from other species, suggests that heterosis varies according to the age of the animals as well as for different conditions of environmental stress, different ecological niches, and different economic stituations. For example, the limited data available suggest that heterosis is greater when environmental stress, limited feed, crowded conditions, and high disease levels act as depressing agents upon productive performance. While this can be taken to mean that hybrids are better able to withstand poor conditions, does it also indicate that they cannot respond noticeably better than purebreds to good conditions?

Another bit of evidence which merits some attention is that the rate of approach to maturity is delayed in inbreds, but that they eventually attain mature size almost comparable to purebreds. For example, note that the depressing effects of inbreeding are no greater in absolute terms and are much less relatively at 18 months than they are at weaning for body weight. Does the same situation exist with crossbreds as compared with purebreds? This latter question has not been examined closely, since most crossbred animals are produced for commercial purposes and are usually marketed before full maturity is attained. Would the greater size in beef cattle be advantageous if it is found to exist? Studies of mortality and growth rate in swine suggest that the heterotic mechanisms operate early in life giving the very young a certain initial advantage which is gradually lost with approach to maturity. As a practical application of this principle, crossbred sows are widely used in the United States where young females are kept for reproduction but are very rare in Europe where average age of sows is much greater.

With the present limited knowledge any attempt at a summary of the important traits in beef cattle necessarily must be incomplete as well as speculative. The best indications at present concerning the usefulness of heterosis in beef cattle production are along the following lines:

<u>Reproductive ability</u>:

Crossbreds are likely to have their greatest usefulness in the South where environmental stress due to high temperatures and parasites in an important factor with some more limited use in the western states where scarcity of food is a problem during certain periods.

<u>Maternal performance</u>:

The evidence presented by Dr. Kincaid suggests that the unimproved areas of the South will find greatest use for crossbreds as mothers because of their ability to produce heavy calves in spite of severe environmental conditions. The chief advantage of crossbreds there lies in the opportunity of combining adaptability from the Zebu and Zebu strains with

European breeds to obtain crosses expressing heterosis. The advantages in maternal performance of crossbreds over purebreds for the West and North Central states are likely to be small.

Growth rate:

The growth rate of crossbreds seems to be about 5 to 7 per cent greater than that of purebreds up to market age, perhaps a little more in the extreme South. Is this alone sufficient to justify the extra trouble and expense of producing crossbred calves? Can this advantage be increased by keeping the crossbred females as mothers and using a rotational system of crossing?

Feed requirements:

The evidence on feed requirements of crossbreds and purebreds is extremely limited in beef cattle. If the situation is similar to that in swine where extensive data are available, no advantage, or at best a very tiny advantage, may be found for the crossbreds. Certainly the difference has been too small to be of economic significance in swine, yet rotational crossing has become the established method of producing commercial pigs.

Carcass characteristics:

There is no evidence at all to suggest that crossbreds have any advantages in carcass characteristics. The data presently available indicated rather clearly that meat of the Zebu strains is "less tender" than that of European breeds and that this characteristic appears to some extent in crosses. The Charolais is similar to the Eruopean breeds in tenderness but would rank high in carcass merit only where lack of marbling was not penalized.

The possible uses of inbreeding were well outlined by Dr. Dinkel, while Dr. Stonaker gave some excellent examples of their practical application. Some problems for which we are seeking answers require the use of closed populations, so that useful information concerning the consequences of inbreeding is a byproduct. In other cases inbreeding is of primary interest. The reduction of genetic variability within lines is undoubtedly a serious handicap to continued improvement from selection when the final purpose of the line is commercial utilization. This can be partially counteracted by forming inbred groups only from superior foundation stocks, not because variability will be maintained to a greater degree, but because the original improvement in choice of stocks will compensate for the later slower rate of improvement. In particular cases it can be partially counteracted by mild outcrosses without destroying the process of family formation completely. Also, one of the major advantages of inbreeding is the increase in between-line variation. To capitalize on this requires culling entire lines so that many original lines must be formed.

Goals and standards are currently undergoing rather rapid change in the beef cattle industry. Under these conditions breeders are likely to make use of individual cases of rather intense inbreeding but probably

will find the formation of definite lines over long periods relatively unprofitable. Inbreeding can be of occasional use as a holding action to retain genes of unusual merit until comparable merit is identified in unrelated animals. But to gamble that a large group of closely related animals can be changed rapidly enough from within the group to maintain its position diring a time of rapid revision of standards is scacely realistic. These periods require searching for extremes and outcrossing to introduce and maintain variability.

A pertinent question was raised concerning the culling of lines for single-gene hereditary defects such as dwarfism. In experimental work in particular, but also with practical breeders to a lesser extent, there are a number of good reasons for continuing a line of breeding that is satisfactory in most respects but is know to have one deleterious gene in frequency higher than usual. For experimental work this may reduce the value of the line only a little. In view of the large number of different kinds of defective genes which exist, probably most animals are heterozygous for one or a few deleterious recessive genes. Why discard a known quantity for not being completely perfect and acquire an unknown one with unknown but equally serious problems?

The above review represents an effort to outline some of the important and challenging problems concerning heterosis and inbreeding in beef cattle. Perhaps I have erred in attempting to draw too many or too definite conclusions from evidence which is as yet too scanty to be accurate.

Research in beef cattle must continue on a sounder and broader scale. The day is long past when the beef cattle industry will go quietly about its business and leave us to work in solitude. Breeders are showing a vital interest, and they will continue to provide their own answers on a trial-and-error basis as they have in the past unless factual information is forthcoming promptly.

EXPERIMENTAL ESTIMATION OF SELECTION RESPONSE IN BEEF CATTLE

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It is one thing to predict progress from selection programs but quite another to determine experimentally what rate of improvement actually is obtained.

As the theory of selection response gradually blossomed, it was easy for us to become so entranced with its intricate beauty and fragrance that we temporarily forgot to check its seed production. We learned how to estimate from correlations among relatives the maximum proportion of the phenotypic variation among individuals in a given environment that could be ascribed to the average effects of genes (heritability). We also thought that we had learned how to predict the rate of genetic change to be expected from heritability, intensity of selection, and length of interval between generations, at least in the rare case of selection for a single trait or for a total score including several traits.

UNCONTROLLED SELECTION EXPERIMENTS

All of this interesting activity was preceded or accompanied by a number of selection experiments with plants and with both laboratory and domestic animals. Superfically, it would seem that all was well, but the fun began when attempts were made to interpret results of these selection experiments quantitatively in terms of the theoretical expectations.

There was no question concerning the reality of genetic change in oil content of corn (Winter), body size in mice (Goodale, 1938; MacArthur, 1949), or even egg production in chickens (Marble and Hall, 1931; Hutt and Cole, 195. Lerner and Hazel, 1947), at least during the early generations of selection. Simple time trends and comparison with unselected stocks were adequate to demonstrate this. However, after many generations of selection, continued progress became less obvious relative to the apparently environmental fluctuations from generation to generation.

These experiments provided only a qualitative check on selection theory, because (1) except for the study by Lerner and Hazel (1947), the selection differentials and statistical estimates of heritability necessary to predict genetic gains were not reported and (2) no attempt was made to measure environmental change over the periods of the experiments.

In the extensive selection experiments with inbred lines of swine, reasonably complete information on heritability, correlations among traits, selection differentials, length of generation interval, and even inbreeding effects was obtained and used to predict rate of genetic change (Dickerson, et al,1954). To be sure, further refinements are needed to predict more precisely genetic response for individual traits when selection is for many traits simultaneously. However, the most serious flaw was the complete confounding of genetic with environmental changes during the course of the experiment. In order to interpret the results at all, one must make unsupported assumptions concerning environmental time trends. Since the gross time trends with inbreeding effects removed were essentially zero for productivity of sows and negative for growth rate, we can conclude that selection was effective only if we are willing

to assume that environmental influences steadily worsened (or that inbreeding deterioration was underestimated). Certainly, in these circumstances even the most remote approach to quantitative verification of selection theory is out of the question. Techniques must be developed and used which will permit efficient estimates of genetic response to selection, unbiased by environmental time trends.

DIFFERENTIAL SELECTION RESPONSE

Selection in Opposite Directions

Environmental bias can be eliminated from estimates of differential selection response by selecting simultaneously in opposite directions beginning with common foundation stock and under a common environment (e.g., MacArthur, 1949; Falconer, 1953, 1955; Kyle and Chapman, 1953; Krider, et al., 1946; Dickerson and Grimes, 1947). However, this approach does not permit estimates of selection response in one direction alone, which, of course, is the chief interest in selection studies with domestic animals.

Comparing Several Methods of Selecting in the Same Direction

This type of comparison is basically identical with selection in opposite directions discussed above, except that the comparison is between methods expected to produce more nearly similar response (e.g. Falconer and Latysgewski, 1952; Bell, et al., 1955). Absolute response is not measured, but some practical information to guide the choice of breeding method is obtained. The chief design requirement is that any potentially uncontrolled environmental influences be randomized between the populations compared.

Comparisons with Breed Average

This is another special case of measuring differential response where one wishes to determine how much more (or less?) response is obtained from some specific selection procedure than occurs during the same period of time in the whole breed or breeds involved in the experiment. Results from such comparisons should reveal not only differences in over-all response to selection practiced in commercial purebred herds and in the experimental herds, but also any differences in emphasis on the components of performance. If breeders pattern their efforts at all closely after those of the experimental breeding projects, there may be little or no differential response simply because both may be producing genetic improvement at similar rates!

Sampling Errors for Estimates of Differential Response

The measure of genetic divergence in response to selection in any two cattle populations is essentially the time trend in the mean difference, experimental minus control (U - C), provided the experimental design eliminates any systematic difference in environmental influences on the two populations. Ideally, the design should insure that the uncontrollable environmental influences are distributed randomly among individuals within and between contemporary populations.

Under these circumstances, the appropriate estimate of linear divergence per year is:

$$\Delta G_d = b(\bar{U} - \bar{C}).\ Y$$

with standard error,

$$S_{\Delta G} = \sqrt{\frac{V(\bar{U}) + V(\bar{C})}{\Sigma y^2}}$$

where: Σy^2 = sums of squares for years

$V(\bar{U}) = \frac{E}{ds} \hat{x} \frac{S}{s} + GY$ = error variance of intra-year mean for the experimental population.

$V(\bar{C}) = \frac{E}{ds'} + \frac{S'}{s'} + GY$ = error variance of inra-year mean for the "control" population.

GY = variance from interaction of the genetic difference between the populations with environmental change from year to year.

S = intra-year variance from differences in transmitted influence of sires producing the experimental population.

S' = same as S, for the control populations.

s and s' are numbers of sires per year in the experimental and control population, respectively.

E = variance among porgeny from different dams but from same sire.

ds and ds' are numbers of progeny per year for the experimentals and controls, respectively.

The importance of using a large number of sires to minimize sampling error is apparent whenever this can be done without interfering with the selec- tion methods under study. For example, when the control is breed average, artificaial insemination may permit sampling the sires being used in many purebred herds without altering intensity of selection in those herds in any way. Also S' from differences among sires used in different herds likely would be larger than S from differences among sires within a single experimental strain.

ABLOLUTE SELECTION RESPONSE

Genetically Constant Control Strains

If a selection experiment provides unbiased and replicated estimates of the total and of the strictly evvironmental time trend in performance, repli- estimates of absolute genetic response can be obtained by difference. In concept, use of a control strain (C) in which the genotypic mean ($\bar{g}_c$) would

remain constant in successive generations would provide estimates of purely environmental change. If it were maintained under the same environment as the selected population (U), absolute genetic response in the selected population could be estimated from the time change in the deviation of selected from control as follows:

$$\Delta G_u = (\bar{U}_2 - \bar{C}_2) - (\bar{U}_1 - \bar{C}_1)$$

It is assumed that smapling error of the strain-year means from strain interaction with yearly environment (ge) and from intra-year environmental variation (e) will be random and hence without bias and reduced by replication

$$\Delta G_u = \Delta g_u + (ge_{U2} - ge_{U1} + ge_{C1} - ge_{C2}) + e_{U2} - e_{U1} + e_{C1} - e_{C2}$$

$$\Delta G_u = \Delta \bar{g}_{\bar{U}} \pm \text{random error.}$$

Just as for estimates of differential response, the efficient estimate of linear genetic change over a period of years would be:

$$\Delta G_u = b_{(\bar{U} - \bar{C}).\,Y}$$

with standard error

$$S_{\Delta G_u} = \sqrt{\frac{V(\bar{U}) + V(\bar{C})}{\Sigma y^2}}$$

Although it may be highly visionary to even discuss the use of a genetically constant control strain in beef cattle selection experiments, it is useful as a standard with which to judge the precision of other more feasible approaches.

Relaxed Selection Control Strains

Genetic constancy of control strains has been attempted through random selection of breeders (Terrill, 1954; Gowe and Johnson, 1956) and through choosing breeders proportionally from each stratum of the population to minimize natural selection (King, 1954; Gowe, et al., 1959).

The kinds of genetic change which could occur in such control strains include:

(1) Changes in gene frequency, from random drift --especially in the small populations feasible in large animal experiments--and from natural selection.

(2) Changes in gene expression, from inbreeding--small effective population size-- and from gradual disintegration of favorable epistatic gene combinations previously maintainted by selection. (See Lush, 1959 Proceedings.)

Genetic change in performance of a "relaxed-selection" control strain would be minimum, (Growe, et al., 1959) if:

(1) The effective size of the control population were large enough to avoid inbreeding and minimuze random drift,

(2) pedigree matings are utilized to minimize natural selection by approaching equal reproductive contributions from each individual in each generation, and

(3) several generations of such matings elapse before genetic stability is assumed with regard to the epistatic effects of genes.

Contemporary Comparisons between Generations

The technique of directly comparing progeny from the complete matings of two different generations using like-aged parents (Goodwin, *et al.*, 1959) is not feasible in cattle because of the low reproductive rate and the high costs per animal. However, some variations of the same basic idea do merit consideration in selection experiments with cattle.

1. Sire-progeny comparisons. In the larger farm animals greatest hope for efficient estimates of absolute genetic gain from selection seems to rest in contemporary comparisons of progeny from sires of different birth-years. This hope is based upon the assumptions (a) that the set of sires used in one year (or their frozen semen) can be retained for use again in comparison with sires chosen from subsequent birth years (Table 1), (b) that age of sire or semen storage does not influence the performance of progeny, and (c) that age and generation of mates, as well as other influences on progeny, can be equalized or randomized between the age groups of sires. The "repeated" group of sires should be the same complete set or a thoroughly representative sample of the sires first used t years earlier. Since genetic change in only the sires contribution is measured, the estimate of average genetic change per year over t years is $\Delta Gs = \frac{2(\bar{X}_{i+t} - \bar{X}_i)y}{t}$ with standard error $S_{\Delta Gs} + \frac{2}{t}\sqrt{2V(\bar{X})}$,

where $V(\bar{X})$ is the error variance of the mean for progeny of each age group of sires within a year, including interaction of year x age group.

Independent estimates of ΔG can be obtained in each of n years, leading to an average estimate of genetic change per year

$$\overline{\Delta Gs} = \sum_n \left[\frac{2\,(\bar{X}_{i+t} - \bar{X}_i)}{t}\right]\frac{1}{n}\text{, with}$$

standard error

$$S_{\overline{\Delta Gs}} = \frac{2}{t}\sqrt{\frac{2\,V\,(\bar{X})}{n}}$$

Notice that the standard error is reduced directly as the time interval between first and repeated use of sires (t) is increased. Using t=2 completely compensates for the fact that only one-half of the total selection response (i.e., the sires contribution) is measured.

The liklihood that fertility of cattle sperm can be maintained for five or more years means that it soom may be possible to measure genetic progress in cattle populations as precisely from intra-year comparisons of sire progenies (ΔGs in figure 1) as could be done if it were possible to maintain a control strain perfectly constant in genetic constitution over an indefinite period of time for comparison with selected populations (ΔGu). Of course, the longer

the interval between the age groups of sires compared (t), the longer the selection experiment must be conducted before the first estimatesof genetic response become available. However, the increased precision of the estimates ($S_{\overline{\Delta G s}}$ in Figure 1) completely justifies the waiting.

Also, the sire-comparison technique has an advantage over use of an independent control strain in that the age group X year interaction is likely to contribute less than strain x year interaction would to experimental error of the estimated genetic change.

It is possible to reduce the standard error even further if the female replacements sired by each age group of sires are always mated to sires of the same age group. This procedure gradually would divide the herd into two separate units--one reproduced each year by mating all females sired by young (e.g., 2 year-old) bulls to the current group of young sires, the other by mating all females sired by repeated old (e.g., 7 year-old) bulls to the current group of old bulls. By this means the difference between progenies of the young and the old groups of sires ($\overline{X}_{i+t} - \overline{X}_i$) in any given year gradually would come to represent 3/4, 7/8, 15/16, 31/32, etc., of the genetic difference ($t \cdot \Delta G$) between the two age groups of sires, since the cows mated to the two age groups of sires would differ in the same direction by 1/2, 3/4, 7/8, 15/16, etc., of $t \cdot \Delta G$. Hence, the average genetic advance per year would be estimated as

$$\overline{\Delta G} = \frac{1}{n} \cdot \sum_{n} \left[\sum_{k} wj \left(\frac{\overline{X}_{i+t} - \overline{X}_i}{p \cdot t} \right)_j \frac{1}{(\Sigma wj)} \right]_y$$

Where: n = number of yearly estimates (Y) averaged

p = proportion of the genetic difference between the two age groups of sires represented in the mean difference between their respective progenies, ranging from 1/2, 3/4, 7/8, etc., to 1.

wj = weighting appropriate for each of the k separate estimates within a year of ΔG for comparisons with differ in p or t, $\Delta Gj = \left(\frac{\overline{X}_{i+t} \; \overline{X}_i}{p \cdot t} \right)$

The standard error of $\overline{\Delta G}$ then would diminish to $S_{\overline{\Delta G}} = \frac{1}{p \cdot t} \sqrt{\frac{2V(X)}{n}}$

As p is changed from 1/2 towards 1, $S_{\overline{\Delta G}}$ ultimatesly would be reduced by 1/2, compared with the plan of distributing all females randomly between the two age groups of sires each year.

The technique of intra-year comparisons between age groups of sires from a population under selection can be applies either (a) within the selected population itself or (b) in separate test-herd populations. Considering the already limited size of most experimental breeding herds, it would seem desirable to explore earnestly the possibilities of measuring selection-response in separate cooperating commercial herds.

2. Dam-progeny comparisons. The chief limitations in estimating genetic change from intra-year comparison of progeny from dams representing different birth years are (a) the difficulty of obtaining unbiased adjustment for age differences in maternal influences on performance of progeny, (b) the shorter

time interval (t) between age groups of dams for which such comparisons could be made, and (c) the certainty that the older groups of dams would be to some degree a selected sample of all dams originally chosen from the same birth year. Nevertheless, some exploration of this approach seems warranted in analyzing time trends in strains of cattle under selection.

Removing Environmental from Gross Change between Years.

It is not feasible in cattle to repeat matings of the same generation and the same age of dam in two successive years to estimate environmental change, but it may well be practical to follow a plan which will permit estimates of genetic change independent of environmental trends. For example, suppose a cattle population is reproduced by selecting several young sires each year and using each sire for two years, mating each age group of sires to a representative cross section of females from all ages and generations.

It is immediately apparent that this is merely a special case of the general plan under which genetic change can be estimated by averaging the n intra-year mean differences between progenies from the two age groups of sires, so that $\Delta Gs = \sum_n \left[\frac{2}{t}(\bar{X}_{i+t} - \bar{X}_i)\right]\frac{1}{n}$, where t = 1. However, it is interesting to note that the mean difference between progenies of the same sires in two successive years $(\bar{X}''_{y+1} - \bar{X}'_y)$ contains all of the environmental change, but only one-half of the total genetic change between years so that

Where: primes indicate progeny from 2-year-old sires, double primes indicate progeny from 3-year-old sires, and subscripts indicate birth year of progeny.

The mean difference between two years in the total population $(\bar{X}_{y+1} - \bar{X}_y)$ of course, includes the same environmental change, but all of the genetic change

$$\Delta P = \bar{X}_{y+1} - \bar{X}_y = \Delta E + \Delta G$$

Hence, the cumulative total genetic change over a period of n years could be estimated as

$$\sum_n \Delta G = 2\left(\sum_n \Delta P - \sum_n \Delta P_1/2\right) = 2\left[(\bar{X}_{1+n} - \bar{X}_1) - \sum_n(\bar{X}_{y+1} - \bar{X}_y)\right]$$

This amounts to subtracting from twice the total difference between the means for the first and last years $(\bar{X}_{1+n} - \bar{X}_1)$, twice the sum of n independent estimates of one-year $(\Delta E + \frac{\Delta G}{2})$ changes $(\bar{X}''_{y+1} - \bar{X}'_y)$ from paternal half-sibs in successive years. Algebraically, this reduces to summing the intra-year differences between progenies from the two age groups of sires:

$$\sum_n \Delta G = (\bar{X}'_1 - \bar{X}''_1) + 2(\bar{X}_2 - \bar{X}_2) + 2(\bar{X}'_n - \bar{X}''_n) + (\bar{X}'_{n+1} - \bar{X}''_{n+1})$$

CONCLUSIONS

A most serious limitation in experimental design of cattle breeding projects has been the complete confounding of genetic and environmental changes between generations.

The simplest plan for removing environmental bias is one which measures only the difference in response between two or more breeding methods. Assuming only random environmental differences between populations within years, the regression of the intra-year mean differences on time is an efficient measure of the rate of genetic divergence.

To estimate the relative effectiveness of two breeding systems, the experiment must measure absolute genetic change in both populations. Absolute response could be estimated as divergence from a "control" population if one could safely assume no genetic change in the "control" over the period of the experiment.

Absolute response to selection can be measured with comparable efficiency and without the assumptions required in using a "genetically constant" control from intra-year comparisons of progeny from the "current" young herdsires with those from the sires first used t years earlier, provided $t > 5$ years. Dependable storage of bull sperm for five or more years should make this alternative feasible. This plan could utilize cooperating commercial herds to supplement the experimental populations.

Because of the time and expense involved, the consequent difficulty of repeating an experiment, it is especially important in cattle breeding work to measure both selection applied and response obtained in all traits likely to be significant for interpreting results.

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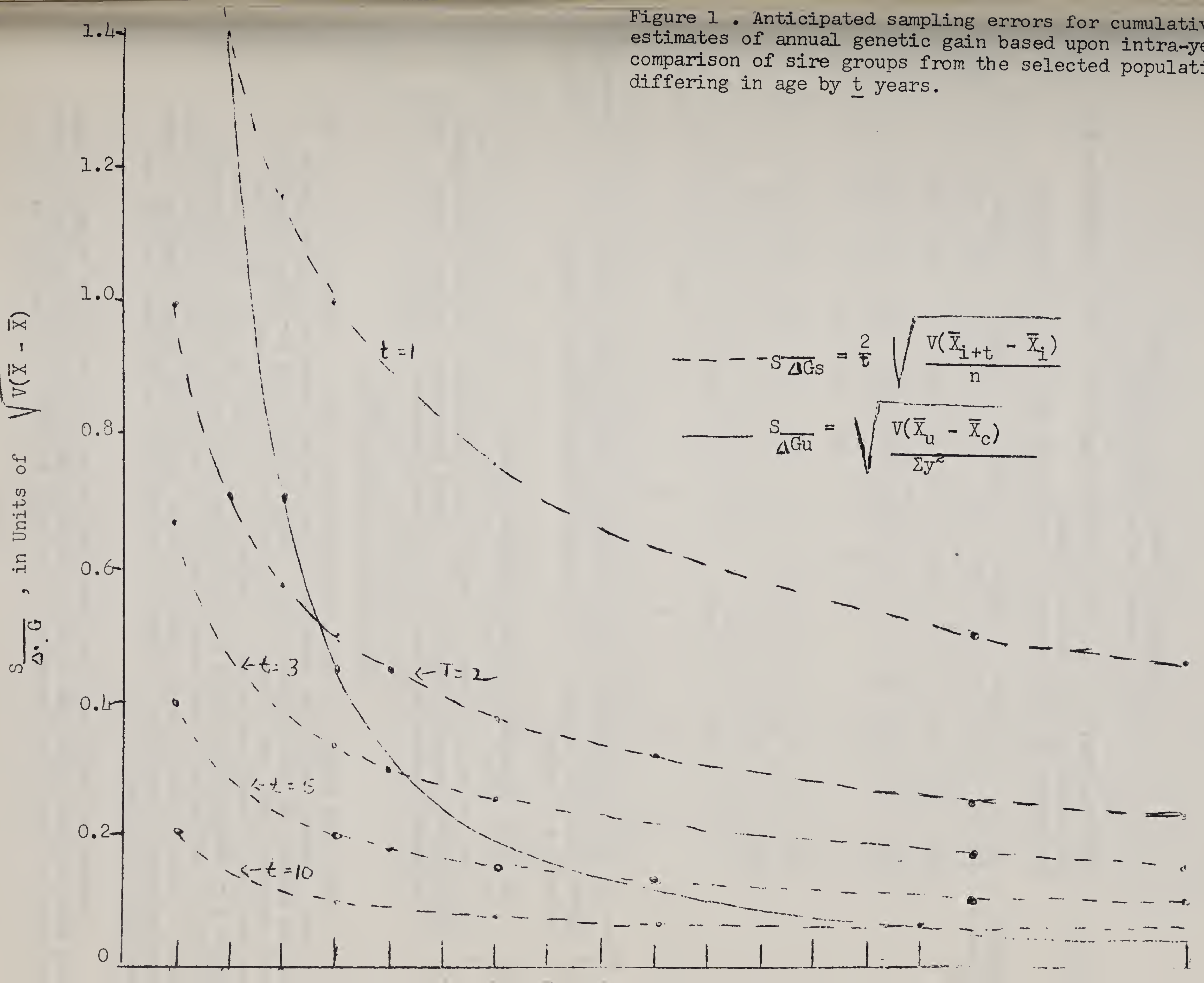
Fifty generations of selection for protein and oil in corn. Agron. J. 44:60-65.

Table 1. Intra-year comparison of sires selected from different birth years

Year	Birth year of sires used At 2 years	Repeated	Dams
1956	1954		
1957	1955		
1958	1956	1954	Distributed randomly, or paired between sire groups.
1959	1957	1955	
1960	1958	1956	

Figure 1 . Anticipated sampling errors for cumulative estimates of annual genetic gain based upon intra-year comparison of sire groups from the selected population differing in age by t years.



Operation and Usefulness of a Random Bred Control Population of Rambouillet Sheep

by

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Table 1. Age Distribution (percent) of Ewes Present at Lambing in Selected (S) and Unselected (C) Control Groups
Percentage of ewes present at lambing of each age for each year

Age in	1954		1955		1956		1957		1958		1959	
years	S	C	S	C	S	C	S	C	S	C	S	C
2	13	100	22	62	24	25	30	32	33	28	26	26
3	30		10	38	19	45	22	22	20	21	24	24
4	18		27		7	30	17	26	16	16	17	18
5	15		15		24		7	20	13	19	14	15
6	16		15		13		14		6	16	9	10
7	7		9		10		6		10		4	7
8			2		3		4		1		6	
9	1								1			

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Explanation of Records Taken

Lambs were weaned and weanling records were taken at about 125 to 130 days of age. Weaning weight was recorded to the nearest pound and staple length at the midside to the nearest 0.2 cm. Scores were taken for type, condition, face covering, and neck folds. Wool grades in spinning counts were taken at the side. These were coded as 1=70's, 2=64's, 3=62's, etc. The weaning index for Rambouillets was 75 minus 15 times face score, plus 7 times staple length in centimeters, plus weaning weight in pounds plus 0.4 times type score, plus 8 times condition score, minus 11 times neck folds score. Weaning records were adjusted to one band, to ewes, to singles from mature dams, and to non-inbreds at 130 days of age.

Records on yearlings were taken just before and just after shearing which was near the last full week in May. The average age was about 415 days. Traits observed at weaning were repeated at yearling age with the exception of index.

In addition, records were taken of clean yield; clean fleece weight from scoring a small side sample; grease fleece weight; belly wool score (coded X 3); crimps per inch at mid-side; shearing fleece, side, thigh and diameter grades in spinning counts (coded as above); thigh grade score (based on difference between fineness of wool on the side and thigh), diameter (fiber diameter estimated by comparator from cross-sections of blended shoulder, back and hip samples) to nearest 0.1 micron and variability of fiber diameter estimated from comparator in standard deviations.

Scores and staple length were taken independently by a committee of 3 experienced animal husbandmen. Some exceptions included belly wool and wool grades which were taken by only one man. The scoring system was the same for all traits evalusted by scoring; sheep considered as having the highest merit were given a score of 1 and those with poorest merit a score of 5. Fifteen possible scoring units were obtained by assigning plus or minus values to sheep having scores slightly above or below the whole unit. The scores given by the three judges were averaged for each sheep and rounded to the nearest 1/3 of a scoring unit.

Individual feeding of part of the control group from 1956 to 1960 was conducted for 84 days during the winter. The diet fed each year consisted of 87.5 percent alfalfa and 12.5 percent oats in pellet form except in 1956 when the ewe lambs were fed straight alfalfa pellets. During the test the lambs were individually self fed and maintained in individual pens indoors with free access to water and salt.

Lifetime averages of ram records were obtained by adjusting available yearling or later records on an estimated mature basis to eliminate differences due to age, year and other environmental effects so that it best represents the breeding value of the ram under range conditions.

The ram index equals body weight in pounds plus 7 times type score, plus 4 times condition score, minus 3 times grease fleece weight in pounds, plus 11 times clean fleece in pounds, plus staple length in centimeters, minus 7 times face covering score, minus 3 times neck fold score.

In the following tables, traits reflecting quality of fleece were ommitted, but data on these traits were included in the material handed out at the meeting.

Table 2. Lamb Production of Selected (S) and Unselected (C) Control Groups

Characteristic	Flock	1952	1953	1954	1955	1956	1957	1958	1959
		Year Lambed							
No. ewes bred	S			210	192	176	181	198	189
	C			32	83	100	100	100	98
No. ewes at lambing	S			204	191	176	180	194	188
	C			31	83	100	99	99	97
Age of ewes at lambing (yrs.)	S			4.2	4.3	4.2	3.9	3.8	3.9
	C			2.0	2.4	3.3	3.8	3.8	3.8
Lambs per ewe that lambed	S			1.48	1.37	1.36	1.28	1.38	1.36
	C			1.07	1.14	1.37	1.33	1.41	1.35
Percent of lambs born alive	S			94	94	97	98	88	95
	C			100	93	88	97	89	96
Percent weaned of that born alive	S			86	88	90	93	88	92
	C			73	96	94	91	91	90
Ave. weaning wt. (lbs.)	S			74	78	73	80	76	74
	C			73	78	73	79	74	76

Table 3. Adjusted Weaning Averages of Traits for Selected (S) and Unselected (C) Control Groups

Characteristic	Flock	1952	1953	1954	1955	1956	1957	1958	1959
No. of lambs	S	65	104	227	197	205	195	197	212
	C	65[a/]	101[a/]	21	80	105	109	97	103
Weaning wt. (lbs.)	S	76.6	82.7	77.3	82.8	79.4	80.0	72.7	79.0
	C	77.0	83.4	76.8	82.7	79.2	79.9	69.9	80.4
Type score	S	2.32	1.94	2.05	2.31	2.38	2.53	3.26	2.78
	C	2.33	1.91	2.03	2.33	2.41	2.57	3.31	2.78
Condition score	S	2.50	2.37	2.52	2.05	2.56	2.72	2.98	2.42
	C	2.55	2.39	2.31	2.06	2.47	2.65	2.92	2.43
Staple length (cm)	S	3.64	3.86	4.02	3.76	3.96	3.87	3.98	4.21
	C	3.53	3.90	3.94	3.63	3.91	3.68	3.93	3.99
Face covering	S	3.41	3.32	3.28	3.22	3.10	2.86	3.17	2.97
	C	3.60	3.27	3.52	3.48	3.43	3.26	3.56	3.53
Neck folds score	S	1.08	1.12	1.21	1.14	1.27	1.15	1.13	1.59
	C	1.13	1.09	1.30	1.16	1.46	1.23	1.27	1.77
Index	S	135	142	139	141	143	149	151	142
	C	132	144	132	136	135	140	130	132

a/ Lambs born in selected groups were divided at random into selected and unselected control groups.

Table 4. Lamb Production of A and B Unselected Control Groups

	Year of Lambing					
	1957		1958		1959	
	A	B	A	B	A	B
No. in flock at lambing	50	50	49	51	51	47
Age of Ewes at Lambing (yrs.)	3.3	3.3	3.7	3.8	3.8	3.8
% of ewes present that lambed	98	92	88	84	86	96
Lambs born per ewe	1.37	1.29	1.52	1.30	1.42	1.29
% lambs born alive	97	97	89	89	97	95
% weaned of those born alive	88	95	91	90	93	85
ave. weaning wt. (lbs.)	79	79	74	73	77	76
lbs. lamb per ewe bred	90	84	79	64	83	76

Table 5. Adjusted Weaning Averages of Traits for Unselected (A and B) Control Groups

No. of Lambs	57	52	52	45	55	48
Weaning wt. (lbs.)	79.7	80.1	71.0	68.6	81.7	78.9
Type score	2.60	2.54	3.29	3.34	2.76	2.81
Condition score	2.68	2.62	2.91	2.94	2.43	2.43
Staple length	3.69	3.67	3.87	4.01	3.99	3.98
Face covering score	3.25	3.28	3.47	3.67	3.68	3.36
Neck folds score	1.22	1.24	1.26	1.28	1.78	1.75
Side grade code	1.72	1.83	2.21	2.41	1.97	1.97
Index	141	140	132	128	130	133

Table 6. Averages of Yearling Traits for Rams of Selected (S) and Unselected (C) Control Groups

	Flock	1952	1953	1954	1955	1956	1957	1958	1959
		Year Lambed							
No of rams	S	14	15	40	39	47	45	41	53
	C	28	47	25	14 1/	20 1/	30 1/	23 1/	18 1/
Weight after shearing (lbs.)	S	133	126	111	122	120	122	130	122
	C	129	115	101	112	110	111	122	122
Type score	S	2.24	2.36	2.49	2.65	2.55	2.78	2.90	2.97
	C	2.36	2.38	2.75	3.12	2.80	2.99	2.97	3.17
Condition score	S	2.17	2.04	2.73	2.62	2.57	2.50	2.57	2.87
	C	2.10	2.15	2.79	2.86	2.65	2.55	2.62	3.00
Face covering score	S	3.21	3.38	3.38	3.46	3.23	3.00	3.02	3.16
	C	3.73	3.73	4.16	3.52	3.70	3.58	3.42	4.13
Neck folds score	S	1.60	1.58	1.67	1.75	1.29	1.50	1.36	1.28
	C	1.65	1.46	1.88	2.00	1.33	1.57	1.45	1.30
Grease fleece wt. (lbs.)	S	11.9	14.6	12.6	12.7	10.2	11.4	11.2	12.0
	C	11.4	13.1	11.6	12.2	8.9	10.6	10.6	11.3
Clean fleece wt. (lbs.)	S	5.5	5.6	5.8	6.2	4.5	5.1	4.7	
	C	4.8	5.0	5.2	5.7	3.9	4.7	4.4	
Index	S	228	226	222	214	216	218	218	
	C	217	216	208	194	205	208	205	

1/ These represent a random part of each group as the other part was individually fed during the winter.

Table 7. Averages of Yearling Traits for Ewes of Selected (S) and Unselected (C) Control Groups

	Flock	1952	1953	1954	1955	1956	1957	1958	1959
Number ewes	S	27	43	58	59	69	51	67	69
	C	34	52	24	13 1/	35 1/	24 1/	25 1/	32 1/
Wt. after shearing (lbs.)	S	91	84	84	97	87	99	97	90
	C	88	84	83	89	87	94	91	86
Type score	S	2.37	2.47	2.45	2.44	2.37	2.88	2.51	2.96
	C	2.55	2.45	2.42	2.79	2.46	2.99	2.61	3.28
Condition score	S	2.31	2.33	2.76	2.45	2.26	2.52	2.30	2.79
	C	2.41	2.33	2.74	2.54	2.38	2.62	2.33	2.98
Face covering score	S	3.79	3.81	4.07	3.11	3.13	3.05	2.94	3.00
	C	4.10	4.03	3.78	3.87	3.58	3.45	3.60	3.89

Table 7 (con't)

	flock	1952	1953	1954	1955	1956	1957	1958	1959
Neck folds score	S	1.43	1.17	1.61	1.34	1.31	1.36	1.35	1.23
	C	1.30	1.17	1.57	1.41	1.45	1.78	1.52	1.32
Grease Fleece wt. (lbs.)	S	10.1	9.6	9.5	10.2	7.8	9.1	11.1	10.7
	C	11.2	9.3	9.2	9.9	7,8	8.8	10.4	9.8
Clean fleece wt. (lbs.)	S	4.3	4.0	4.3	4.7	3.9	4.4	4.3	
	C	5.1	3.8	4.2	4.4	3.8	4.0	3.9	

1_/ These represent a random part of each groups as the other part was individually fed during the winter.

Table 8. Averages of Yearling Traits of Group Fed (NF) and Indivudually Fed (F.) Lambs from the Unselected Control Group

		Year Born									
		Rams					Ewes				
	Flock	1955	1956	1957	1958	1959	1955	1956	1957	1958	1959
No. of sheep	NF.	14	20	30	23	18	13	35	24	25	32
	F	24	24	24	23	24	16	24	23	22	23
Wt. after shearing (lbs.)	NF	112	111	111	122	122	89	87	94	91	86
	F	137	129	134	133	135	102	98	99	98	97
Type score	NF	3.1	2.8	3.0	3.0	3.2	2.8	2.5	3.0	2.6	3.3
	F	2.5	2.4	2.6	2.6	2.8	2.2	2.1	2.8	2.5	2.7
Condition score	NF	2.9	2.6	2.6	2.6	3.0	2.5	2.4	2.6	2.3	3.0
	F	2.1	2.5	2.2	2.4	2.6	2.1	2.0	2.4	2.2	2.4
Face covering score	NF	3.5	3.7	3.6	3.4	4.1	3.9	3.6	3.4	3.6	3.9
	F	3.6	3.6	3.6	3.6	3.7	3.5	3.5	3.4	3.7	3.6
Neckfolds score	NF	2.0	1.3	1.6	1.4	1.3	1.4	1.5	1.8	1.5	1.3
	F	2.1	1.6	1.7	1.6	1.5	1.4	1.5	1.4	1.6	1.3
Grease fleece wt. (lbs.)	NF	12.2	8.9	10.6	10.6	11.3	9.9	7.8	8.8	10.4	9.8
	F	13.2	10.4	11.8	11.4	13.0	10.9	8.6	8.6	11.1	11.0
Clean fleece wt. (lbs.)	NF	5.7	3.9	4.7	4.4		4.4	3.8	4.0	3.9	
	F	6.3	4.6	5.4	5.0		5.1	4.3	4.1	4.7	

Table 9. Adjusted Lifetime Average Records of Rams Used in Breeding of Selected (S) and Unselected (C) Control Groups

	Flock	1952	1953	1954	1955	1956	1957	1958	1959
		Year of Use							
No. rams available	S	71	30	96	62	62	62	56	49
	C		28	47	25	37	44	54	46
No. rams in breeding	S	4	3a/	3	3	2b/	2c/	3	3
	C		7	17	20	20	20	20	20
Grease fleece wt. (lbs.)	S	17.6	18.3	18.6	18.7	19.8	17.8	18.3	19.1
	C		16.2	16.8	17.1	17.8	17.4	16.6	16.9
Clean fleece wt. (lbs.)	S	9.4	10.1	9.5	9.3	10.2	8.9	9.0	8.9
	C		8.6	8.6	8.4	8.9	8.5	8.1	8.2
Staple length in cms.	S	9.1	9.6	9.3	8.6	8.6	9.2	8.9	8.6
	C		8.6	8.2	8.1	7.9	8.8	7.8	8.2
Wt. after shearing (lbs.)	S	188	189	192	183	186	188	182	188
	C		174	175	169	165	179	166	169
Type score	S	1.80	1.70	1.80	1.97	2.05	2.10	2.10	1.73
	C		1.89	1.95	2.12	2.36	2.23	2.24	2.06
Condition score	S	1.75	1.67	1.70	1.83	1.90	2.10	1.97	1.70
	C		1.73	1.83	1.90	2.10	2.14	2.28	1.98
Face score	S	3.28	3.57	3.27	3.27	3.40	3.35	3.20	3.07
	C		3.89	3.98	4.30	4.10	4.03	4.10	4.04
Neck folds score	S	1.65	1.77	1.57	1.67	1.65	1.50	1.60	1.60
	C		1.67	1.56	1.86	1.97	1.87	1.78	1.75
Index	S	239	243	242	231	240	236	233	231
	C		217	215	206	213	219	204	206

a/ One ram lamb used in addition for which records were unavailable.
b/ Two ram lambs used in addition for which records were unavailable.
c/ Three ram lambs used in addition for which records were unavailable.

Table 10. Adjusted Average Records of Rams Used in Breeding (B) Compared with Those Available of Same Age from the Unselected Control Group (A).

	Flock	Year of Use. 1953	1954	1955	1956	1957	1958	1959
No. of rams	A	28	47	25	37	44	54	46
	B	7	17	20	20	20	20	20
Grease fleece wt. (lbs.)	A	16.2	17.0	17.3	17.7	16.9	16.5	16.9
	B	16.2	16.8	17.1	17.8	17.4	16.6	16.9
Clean fleece wt. (lbs.)	A	8.6	8.7	8.5	8.8	8.2	8.1	8.1
	B	8.6	8.6	8.4	8.9	8.5	8.1	8.2
Staple length in cms.	A	8.5	8.5	8.2	7.9	8.4	8.0	8.2
	B	8.6	8.2	8.1	7.9	8.8	7.8	8.2
Wt. after shearing (lbs.)	A	175	173	171	167	174	167	169
	B	174	175	169	165	179	166	169
Type score	A	1.91	1.98	2.10	2.34	2.28	2.31	2.07
	B	1.89	.195	2.12	2.36	2.23	2.24	2.06
Condition score	A	1.81	1.84	1.92	2.11	2.16	2.18	1.98
	B	1.73	1.83	1.90	2.10	2.14	2.28	1.98
Face score	A	4.03	3.87	4.27	4.07	4.03	4.11	4.10
	B	3.89	3.98	4.30	4.10	4.03	4.10	4.04
Neck folds score	A	1.69	1.58	1.83	1.93	1.79	1.75	1.75
	B	1.67	1.56	1.86	1.97	1.87	1.78	1.75
Index	A	217	216	208	209	208	206	205
	B	217	215	206	213	219	204	206

Genetic Environmental Interactions

Jay L. Lush

Introduction

I will discuss first what we really mean by genetic environmental interactions; second, their importance in nature; third, their importance in animal breeding; fourth, how to measure them experimentally; and fifth, the differences in our plans if we breed for maximum adaptation to special situations as compared with our plans if we breed for maximum adaptation to the average of all those situations.

Definition

Genetic-environmental interactions exist whenever the phenotypic differences among two or more genotypes are genuinely different from environment to environment. Another less specific way to say this is that some genotypes excel in other environments. Another way, some what closer to the terms the naturalist uses, is that genotypes or breeds or local races or species vary in their adaptability to different ecological niches. Expressing it somewhat more statistically: The actual phenotype is not simply the sum of the average effects of the genotype and the environment; that is, variations in environment and genetic variations do not combine their effects entirely linearly or additively.

All these are merely ways of saying that the whole is something more or something less than the sum of its parts. Most of our biometry and statistical methods proceed as if all relations were linear. Probably none of us believe that all relations really are linear, but routine practice using only linear methods dulls our sensitivity so that we drift rather far toward <u>acting as if</u> we believed it. Most of us go no further in doubting it <u>actively</u> than to express the pious hope that the answers we get by using linear models may approximate the truth, "well enough for our purposes," whatever those may be! Some of you may have seen, as I did, a delightful little article in the American Scientist for June, 1960, entitled "Life Can be so Non-linear"! But this is getting a little philosophical and very far from beef cattle!

Figure 1 is a graphic and schematic example to illustrate not only what genetic environmental interactions mean but also some of the difficulties we encounter in trying to interpret data in which such interactions are present. The numbers represent four different environments under which animals of four different genotypes (A, B, C and D) are grown and measured. Consider environment number 1 as the standard or usual one. In that environment A is two units above B, while the latter is 3 units above C and D is one unit below C.

Under environment number 2 each phenotypic difference between these four genotypes is exactly twice what it was under environment 1.

We have something like this in the back of our minds if we speak of providing an environment which will permit individuals to express their differences more fully than under ordinary or standard environment. This difference between the way they perform in environments 1 and 2 is a form of genetic environmental interaction if we try to use the analysis of variance directly, because the variances under environment 1 and under environment 2 are not homogenious. It is easy, however, to circumvent this difficulty by using some transformation of scale, such as taking the logs of the actual data which will make the variances uniform and then proceeding to analyze the transformed data.

In environment 3 the four kinds of genotypes still <u>rank the same</u> as they did under environments 1 and 2, but the differences between them are changed irregularly in a very disproportionate fashion. This poses more difficulty. Finding a transformation which will remove the interactions between 3 and either 2 or 1 may perhaps be possible, but it will be difficult. In actual data encumbered also by sampling errors, we can be practically certain that we will not find a <u>perfect</u> transformation for a case like this, although we might find one which would remove enough of the non-linearity that an approximate analysis could be possible.

In environment number 4 not only are the differences disproportionate, but even the ranks are reversed. C, which was only third best under the environment 1, is now second while B, which was second best, is now second poorest. I do not suppose any transformation exists which would enable us to pool in a single analysis data from environments 1 and 4. We just have to accept the fact that A, under environment 1, behaves phenotypically quite differently from A under environment 4. Likewise, the phenotype of C under environment 4 changed much from what it was under environment 1 and in an utterly different direction and extent than did the phenotype of A. That is, the A - C difference under environment 1 is an entirely different thing from the A - C difference under environment 4.

The problem we face in trying to measure the importance of genetic environmental interactions perhaps can be seen more clearly by extending Falconer's approach and considering the phenotype of A under environment 1 as one character and the phenotype of A under environment 4 as another character of the smae individual. Then we could consider the genetic correlation between each individual's measurement in one environment and its measurement for the same character in the other environment. Then r_{14} can be considered the genetic correlation between the expressions of a character in environment 1 and in environment 4. This correlation would be 1.0 if no genetic environmental interaction existed. Indeed, it would also be 1.0 as between environment 1 and environment 2, because correlation (unlike the analysis of variance) does not require homogeneity of the variance of the two characters being compared. (Heterogeneity of the variances shows up in the regressions but not in the correlations). The genetic correlation between 1 and 3 or between 1 and 4 or between 3 and 4, would, however, be something less than 1.0. Under extreme

cases, as 1 and 4 are pictured here, it might even be negative.

Figure 2 shows in another and perhaps simpler way the meaning of genotype-environmental interactions. It diagrams the effects of three environmental levels on the three genotypes which are possible with a single pair or alleles. The left part of the diagram shows how this would be if there were no interaction, while the right hand side shows how it might be if the heterozygotes were so well buffered that the fifferences in environments had little phenotypic effect on them but the AA homozygotes were highly responsive to environmental changes. The line for medium environments if the same in both parts of the diagram. Figure 2 is patterned after Figure 24 in H. L. LeRoy's "Statistische Methoden der Populationsgenetik".

Importance of genetic environmental interactions in nature

This is the widely discussed and well known fact that different species are adapted to different ecological niches. It is an important part of every discussion of evolution and of most discussions on biological topics.

As between distantly related groups, this becomes so extreme that everything else about the differences between them pales into insignificance. Compare, for instance, how well or poorly the mouse and the hippopotamus would thrive in a series of different environments. To take a less extreme example, compare the adaptability of horses and of sheep to open plains, to forests, to high mountains, to marshy country, etc. Examples as extreme as this are so obvious and well known that it would waste our time to dwell on them longer.

As between closely related species, the case is not at once so clear, although often one can see clearly at least a few differences of this kind. Modern evolutionary thought and, indeed, some things written in Darwin's time agree, however, on the principle: "Complete competitors cannot coexist". It can also be stated: "Ecological differentiation is the necessary condition for coexistence". (Here, it is assumed that the two or more groups do not interbreed, so that the question of what their hybrids would do does not arise). Hardin gives a fairly full and interesting discussion of this in the Science 131: 1292-1297, in April, 1960. According to this, genetic environmental interactions always exist in nature, at least as between species which do not interbreed and which live in the same region.

An interesting sidelight on this is Haldane's contention that there are no "superior" or "inferior" races or other subgroups. The argument runs that, if there ever were any species, races, or other groups less fit in all respects, these would have been displaced long ago, at least wherever competitors can reach the same region with them. Likewise, if any ever were genuinely superior in all respects those would long ago have displaced the others. Therefore, where several exist and are not kept completely separate by geographic barriers, each is better adapted to at least one peculiar circumstance or

environment or niche than the others and less well adapted to other circumstances. The danger of reasoning in a circle is present here, of course, but the argument has at least a faint aura of plausibility. Indeed, we often extend it to those genes which are at intermediate frequencies in a breed, inferring that each gene adapts its possessor better to some circumstances and less well to other circumstances than do the other alleles at that locus. This give us over-dominance, or at least what amount to the smae thing, operationally, as far as I can see.

Likewise, it can be argued with considerable plausibility and a wealth of always incomplete evidence that nature favors an intermediate degree of adaptation to special conditions. Too perfect and rigid adaptation to one special set of conditions (that is, being extremely specialized so as to make the very most out of the conditions in a certain locality or climate) is likely sooner or later to lead to extinction as those conditions change, even if the changes are rare and only cyclical or irregular. On the other hand, if a species is not adapted well enough to the various special sets of conditions encountered in its territory, it can't exploit thoroughly the varied niches it will encounter. Then some better adapted competitor will drive it out of those niches until such time as those conditions change enough to exterminate that competitor. The real situation is, of course, complex beyond our power to describe and must depend much on the size of the niche, the mutual accessibility of various niches, etc. Still, we can be reasonabley certain that nature will have favored some intermediate degree of adapability or specialization wherever perfect adaption to one set of conditions automatically makes for poor adaptation to other niches which are in the same territory and which might be exploited. Sewell Wright emphasized (in 1931 and again in 1932) that selection must often have been for enough flexibility in the individual organism that it could adapt itself at least moderately well to a rather wide range of environments.

As nearly as we can piece together the scanty evidence on evolution, extreme specialization has almost always been a prelude to extinction, while the dominant forms of each era always came from somewhat unspecialized ancestors in the preceding era. When the unspecialized or generalized ancestor proceeded to divide into many specialized groups, these flourished at first and then in turn met extinction and were succeeded by the descendants of some contemporary which had remained more generalized.

We can, therefore, be certain that genetic environmental interactions are highly important in nature, at least as between non-interbreeding groups. That they are important in the differences <u>between individuals</u> within a rather freely inter breeding group seems likely, but is not so certain.

Importance in Animal Breeding

Breed differences in adapability have long been a part of the tradition of animal breeding although not often measured even approximately.

The differences have sometimes been related to major economic purposes and sometimes to geographic or other natural conditions.

As examples of niches determined largely by economic differences, some breeds of cattle are well adapted to the needs of a man who wants to dairy, but other breeds are better adapted to the needs of a man who wants to produce beef. Also consider how the relative importance of many breeds of swine was upset during the last 40 years when lard declined from one of the most valuable products of the hog to become only a by-product which could be sold at all only at a low price. A simialr, but probably less extreme, upset among beef cattle may be imminent if, as some signs suggest, fatness may become penalized instead of prized.

As an example of ecological niches determined by climatic or other geographic conditions, consider how the European breeds and the Zebu breeds generally differ in their adaptability to extremely tropical climates. For more than a century much has been said about certain breeds of sheep being adapted to hills or mountains, other breeds to arable land, others to marshy country, etc. A combination of geography and economics makes the Merino supreme in the semidesert back country of Australia, but the Merino gives partical ground to the Border Leicester in the surrounding zone of gentler climate and to such mutton breeds as the Dorset and the Southdown in those coastal strips where the pastures are really good and life is gentle. Consider, also, the adaptation of a breed like the Scotch Highland cattle to misty granite mountain country where geography and economics do not encourage dairying as contrasted with the adaptability of the Brown Swiss in a country like Switzerland which is even more ruggedly mountainous but with bright sunlight and where moderately intensive dairying is practical. In Denmark, the few Shorthorns are kept mostly in the marshy lands where vegetation of a sort is luxuriant but the topography and distances make it impractical to bring the cows in for frequent milking as contrasted with the Red Danish cattle on the tilled land where farms are small, labor is abundant, and the cattle need never be far from the farmstead. In North Central Europe, as in the Netherlands and much of northern Germany, some breeds or types are generally conceded to be better adapted to rich and fertile lands, others better adapted to thin and sandy soils. Some breeds are adapted generally to much of the lowland country, but others are better adapted to the hill or mountain country.

All these things are traditional and only partly supported with actual evidence, but belief in them is so widespread that I think some grains of truth must be among them even if some superstitions and baseless ideas are included, too. For the most part, they have not been measured at all carefully, but surely at least a little reality is in them.

Whether genetic environmental interactions are important within breeds is largely unknown. They can hardly be distinguished from unexplainable individual peculiarities as long as the breed is almost freely interbreeding. That is, in a freely interbreeding population important individual differences in local adaptation might exist but

would keep appearing and disappearing with Mendelian segreagation and recombination, somewhat as waves on the ocean make certain parts of the surface high and certain parts low at any given moment; but the locations of these heights and hollows are continually changing as the waves move on. If a breed were to become subdivided into largely non-interbreeding segments, then differences in adaptability of the various segments, each to different ecological niches, might become almost as apparent and widely recognized as are the differences between breeds.

Some scattered bits of evidence suggesting that genetic environmental interactions may be important among individuals within breeds will be mentioned in the next section.

How to measure individual genetic environmental interactions.

We would like to grow and measure the same individual animal in each of the ecological niches concerned, but this is obviously impossible. The next best step is to find animals nearly alike genetically, distribute these among the environments in a well-designed experiment, measure how they respond to each environment, allow for their not being perfectly identical genetically, and draw the conclusions. Identical twins offer an opportunity to make the same animal live two different lives so to speak. The opportunity is extremely restricted because of (1) the rarity of such twins, (2) the costs and other difficulties of assembling them, (3) the fact that the prenatal and, at least, a little of the postnatal environments of the two members of each pair will have been in common and the effects of this may carry over for a considerable time, and (4) that each pair consists only of two, which means that each pair can furnish evidence on only two environments.

I became intensely interested in identical twins (as does almost everyone else who sees much of them), because the two members of a pair often seemed more like each other in the same lactation than each was like herself in a subsequent lactation. That is, the contemporary resemblance between identical twins seemed higher than the repeatability of a characteristic on the same individual. If only one pair of twins had been under observation at a time, this would readily have been interpreted as testimony that unrecorded general environmental differences varying from time to time were much more important than we had been thinking. However, I thought I saw some striking cases where several pairs of twins were contemporary and in a given week or month both members of one pair would go down in production while both members of another pair went up, for example. This seemed to exclude the explanation based on the importance of an unnoticed variation in common or general environment, but it left wide open the possibility that the genotype of one pair was such that it responded favorably to cold wet weather for instance, while the inevitably different genotype of another pair was such that it would respond unfavorably to that same environmental change.

We began our own experiments with identical dairy twins in 1955 partly with this in mind. We can try only two environments at a time, and naturally we may not have chosen two which will show a marked genetic environmental interaction. If we had numbers enough, we could overcome this, at least partially, by trying three or more environments and using balanced incomplete blocks; but that still seems outside the physical and financial limits under which we work.

At Wiad in Sweden one of the main objects in their nearly thirty years of experimenting with identical twins has always been to hunt for genetic environmental interactions. Professor Hansson tells me that in only one environmental contrast have they found clear evidence that genetic environmental interactions were important. That was in the effects of extremely unequal intervals of time between milkings. This is a little discouraging to those who would solve this problem by experiments with identical twins, but even in 20 years they at Wiad have been able to study only a few contrasting environments after all. Our people who work with the physiology of reproduction will make us a most valuable gift, indeed, if they can discover how to treat the mother or the fertilized egg so as to develop identical quadruplets or even larger sets! What we need here are clones such as the plant breeders have in some, but not all, plant species. Perhaps an apprenticeship with the plant breeders, helping him analyze their clonal data to measure these interactions, might at this stage reward us more handsomely than groping in the semi-darkness toward a direct solution of this on cattle. Yet, I am not optimistic about getting directly usable findings from the plant material, since, for many reasons results obtained about interactions in one species will be less surely transferable to another species than results about most of the other parameters in applied genetics.

Incidently, I should add that already our studies of the identical twins have suggested several other partial (but incomplete) explanations for the well-nigh universally observed fact that identical twins are much more alike than the resemblance between fraternal twins would lead us to expect. An approach to experimental material as suitable as identical twins can be had by comparing many varieties at many locations or under many environments. The effectiveness of this depends, however, on the varieties being genetically very different from each other and the individuals within each line differing very little from each other genetically. In corn and (to a lesser extent) in chickens that has been achieved by inbreeding. Comparing the inbred lines themselves may not be suitable on account of their lowered vitality and perhaps because the homozygotes may be less well buffered against environmental variations, but one can compare a series of F_1's. An F_1 should be genetically as unifrom as an inbred line (although the differences among F_1's are less than the differences among inbred lines) and, in addition, would be better buffered against environmental variations <u>if</u> it is true that heterozygosity often has such a buffering effect.

The corn yeild tests conducted at a variety of locations in most states and the random sample tests and the multiple farm tests comparing many strains or crosses of chickens suggest the general kinds of

techniques we would probably need to use in testing beef cattle for genetic environmental interactions. Some studies in the corn yield tests have already measured separately the interaction of varieties with year-to-year differences and the interaction of variety differences with location differences. The former probably cannot be used practically until weather can be predicted nearly a year in advance. That is, we could make little or no practical use of knowing that variety Q beats variety W in a wet year, but W beats Q in a dry year, unless we know before planting time whether this year is going to be wet or dry! The interactions between variety differences and location differences, however, can be useful if we can identify the environmental factors in the location differences, which make the varieties change rank from place to place. Plant breeders are already doing considerable of this when they recommend one variety for rich soils, another for soils of medium fertility, another for poor soils; or when they recommend some for more northerly regions and others for regions farther south, or different ones in regions with heavy rainfall from what they recommend in regions with scanty rainfall. Probably they need to go farther in that direction in plant breeding than we should in animal breeding since each plant is tied to a fixed environment, whereas the animal more nearly carries its own environment around with it. Also to some extent each animal tends, through the buffer mechanism in its physiology to keep many important parts of that environment nearly constant. Such reasoning leads one to expect a priori that genetic environmental differences are more generally important in plant breeding than in animal breeding. Yet that is far short of saying that they are so unimportant in animal breeding that we can ignore them without loss.

Such are analysis of a multiple farm test in poultry can be seen in Tables 5 and 8 on pages 260 and 262 of Volume 35 of Poultry Science in 1956 by Hill and Nordskog.

For most of our farm animals, especially so for beef cattle, we cannot make so many varieties nor make them so different by inbreeding as is readily possible in breeding some plants. An alternative, which is slightly different in principle but still rests on much of the same argument, is illustrated by such experiments as those of Falconer on mice or those on swine at Pullman, Washington. The general plan is that from a single foundation stock, one line will be selected under one environment and another under a different environment, the selection being toward the same goal (such as rapid gain) in both lines. For experimental purposes it seem necessary to select a control line at the same time in the opposite direction and this likewise is selected under both environments.

After several generations of selection have succeeded in pulling the lines apart, portions of each are switched to the other environment, and the differences between them on the new environment are compared with the differences they showed in the environment under which they were selected. I need not go into the details of this, but the reports on these experiments are likely to repay careful study. They suggest some moderately important practical applications. Necessarily, this will be a difficult undertaking with beef cattle where the generation interval would be around five years, and one

would hardly expect to demonstrate clearly even a moderately important difference until selection has continued for at least three generations. Probably at least two more generations would be required for the testing. Starting an experiment which is likely to require 25 years to yield decisive results will not appeal to some of your Directors, as they are likely to have been in closer touch than you are with such professional statistics as the average length of time a research worker stays at one post without changing his mind (!) or the frequency with which a fire, a disease, a budgetary retrenchment, or some other disaster may wipe out some experiments!

As to what might be done right now with a reasonable prospect of showing some results within five or eight years, an apparently promising procedure is to divide the progeny of a sire among two or more treatments or locations and to study the results as if performance under environment K were a different character from performance under environment S, etc.

This is analogous to what some of you have already been doing in computing genetic correlations by using the variance component between sires. This is not a sensitive test, especially for the whole of the genetic differences, since half-sibs are expected to have only one-quarter of their genic effects alike, only 1/16 of their epistatic effects which involve two non-allelic genes, 1/64 of those involving three non-allelic genes, etc., and none of the dominance effects. Thus, this technique would pick up little except the genic effects and would require large numbers for decisive results concerning those. Still, can you think of any better technique? With all its shortcomings, this seems now a better thing to do than to plan a 20 or a 30-year experiment and merely collect data for many years until, and if, the results are ready to be analyzed. Struggling to make an analysis through studying the sire component of covariance in two or more environments may reveal possibilities which have not yet occurred to any of us. If maternal effects are important, the sire component won't work as well.

This might be a place where using even moderately inbred sires would be profitable. Thus, if the sires were inbred 20 per c nt, one would expect to pick up 36 per cent of the genic differences instead of 25 per cent and nearly 13 per cent of the two-gene epistatic effects instead of barely over 6 per cent. If using partially inbred sires actually would increase the sensitivity of the experiment as much as I am speculating here, this might be well worth doing. Not many years are needed to produce numerous moderately inbred sires, whereas the time required to produce highly inbred lines which could be used as the inbred lines of corn are used seems practically prohibitive in beef cattle.

Breeding for specific as contrasted with breeding for general adaptability.

The latter is simpler but, if and when you succeed, your product won't utilize every local situation fully. The former is more complicated and more expensive but seems the only way to get high local adaptability in those cases where good adaptability to one situation automatically means poor adaptability to another.

A practical question is: How many different strains can one firm produce and keep in stock for sale to its customers? If a beef cattle breeding firm can handle only one strain, then in the commercial aspects of its selling this becomes just like interbreed competition. The corn breeding firms generally offer (although not all in one place) a dozen or more different strains for sale different localities or for different types of soil regions or for different dates of maturity. This must involve much bookkeeping and a rather complicated breeding program but they get the job done. They almost surely think it profitable or they wouldn't continue. Some poultry breeders offer as many as three different strains, each supposedly superior for different purposes or localities or conditions. I suppose there is no basic reason to prevent them offering to their customers six to ten except the increased complication in bookkeeping and the very considerable increase in overhead breeding costs. It must cost nearly twice as much to breed two varieties, each for a separate purpose, as it costs to breed one variety. Unless the market volume is thereby increased, this almost doubles the overhead costs per chick of the breeding research and other efforts. At present, (as I get it through remote gossip) the firms who have gone fartherest in this direction do not suppose they will ever offer their customers more than five or six strains in the foreseeable future. In some cases two differently named strains will have one, two, or three of their four grandparental stocks alike, thus making some reduction in the overhead costs per strain offered the customer.

If we do breed for specific adaptability, the cardinal principle seems to remain that we should rear and test the breeding stock under the conditions under which they or their descendants are intended to be used commercially. A few slight exceptions to this may be mentioned. First, it might be possible to find some environmental condition which would stretch out the genetic variation or diminish the environmental variation or both without at the same time upsetting the unknown selection coefficients which we want to apply. This will be rather difficult, but it does not seem completely impossible. A special example is that one breeding for disease resistance may want to expose his breeding stock or, at least, expose samples of their sibs or progeny to conditions which promote a higher incidence of disease than would be economically endurable for his main breeding flock. This is primarily because of the threshold nature of the practical measurements of disease resistance. Another possibility very like the last in principle is the suggestion of Nichols some twenty years ago concerning breeding Merino sheep to be better adapted to the harsh conditions "outback" in Australia. It isn't practical to keep the good stud flock in those regions because the occasional but irregular occurrence of drouths would cause economically prohibitive losses from time to time. Nichols suggested that the stud flocks remain in the regions with somewhat milder climates but that samples of each stud ram's progeny be sent into the interior. Then a year or so later a report would come back on how well each set of offspring survived and produced under the conditions there. From such reports the breeder would decide whether to continue or to discontinue using each stud ram in the stud flock. For various reasons some of which may be only the physical and financial

difficulty of collecting mortality and other pertinent data on these progeny samples from far-away ranches where a single paddock may contain 10 to 30 square miles, this suggestion of Nichols seems not to have been adopted widely, if at all. It still appears sound as far as the genetic theory is concerned.

An important feature of breeding for specific adaptability is that, if one is going to make much more headway after the first two or three generations, he needs to throw an almost complete pedigree fence around the special stock by that time and thenceforth either to introduce no outside blood at all; or, if any is to be introduced, to grade it up to the stock by several topcrosses before bringing in a very mild outcross. If this is not done, half of the current adaptability to local conditions achieved by selection under those local conditinns will tend to be lost with each successive outcross. If adaptability is genetically at all complex, as it surely must be, selction against such a flood of incoming genes would be almost completely powerless. To take a concrete example, if we try to breed Jerseys in Florida for adaptability to Florida conditions but every generation or two introduce some herd sires from Vermont or Oregon, most of the progress we make by selecting in Florida will be undone by the outcrossing unless, as is unlikely in this illustration, selection was in the same direction in the stocks from which the outcross blood came.

Conclusion

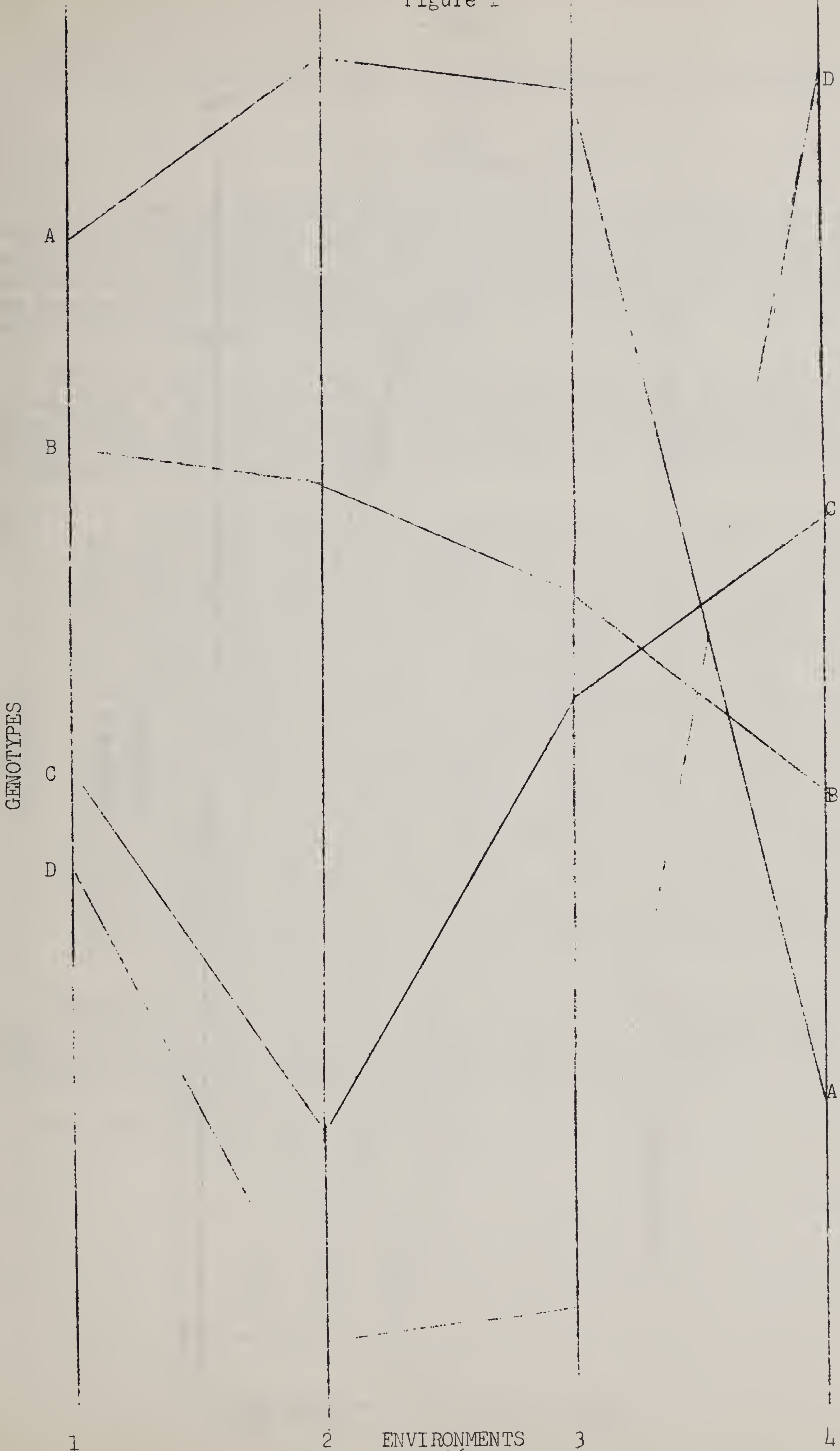
Certainly some genetic environmental interactions exists. How much is uncertain. Our first duty in this respect is to find out the facts.

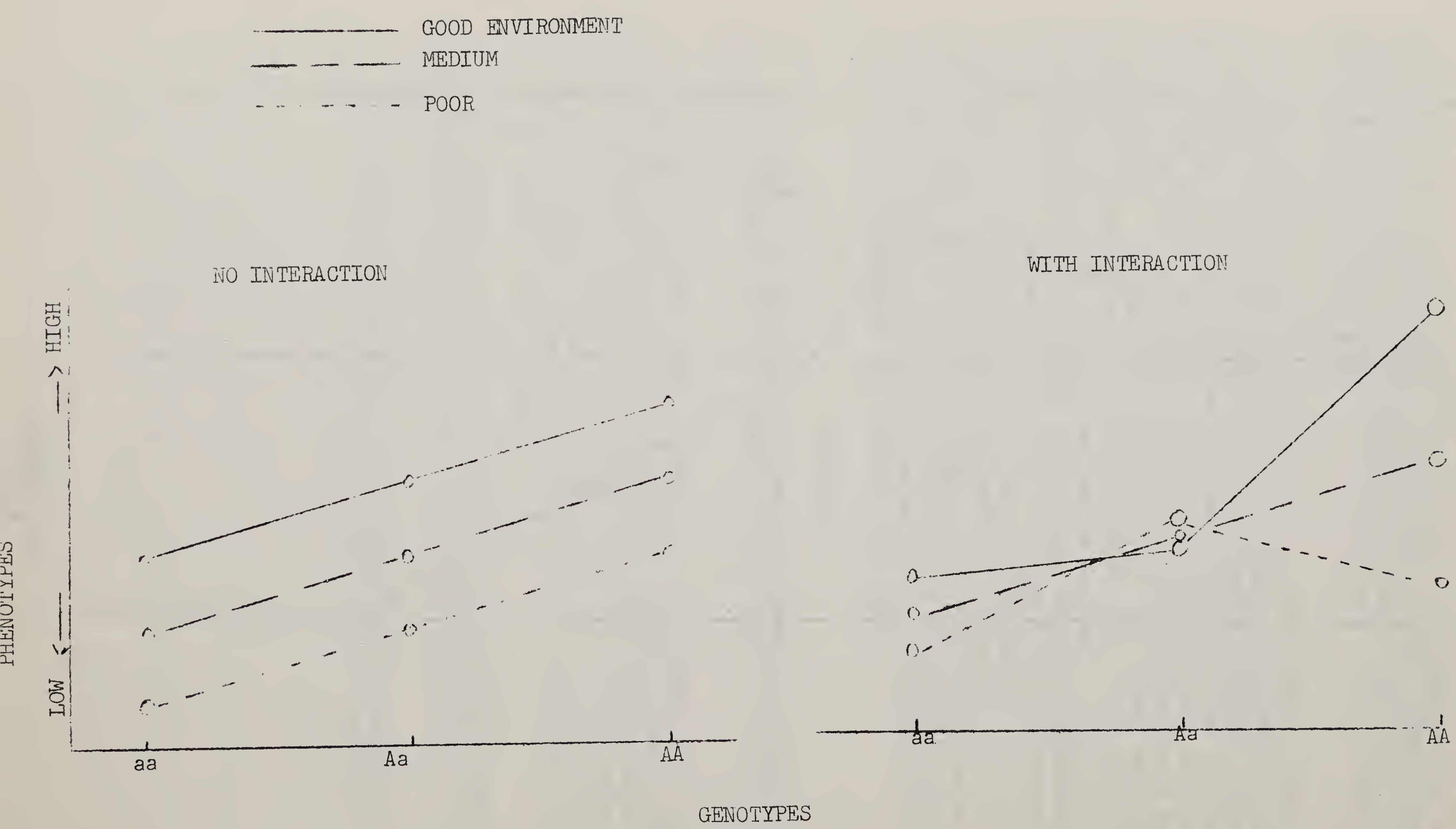
The extra overhead costs of making another "breed" need then to be balanced against what could be gained by exploiting more fully another ecological niche if we had that specially adapted breed. The answer will be different in different cases. It will depend much, among other things, on the size of the niche which is to be filled, how well or poorly a generalized breed can fill it, and the extra costs of making a special strain.

If breeding for adaptability to a special niche does seem worth while, the next step is to lay out schemes for achieving this specialized adaptation and utilising it.

The final step (which, of course, would never be entirely completed) would be to refine and to make improvements in these schemes.

Figure 1




GOOD ENVIRONMENT
MEDIUM
POOR
NO INTERACTION
WITH INTERACTION
PHENOTYPES
LOW
HIGH
aa
Aa
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aa
Aa
AA
GENOTYPES

Figure 2

DISCUSSION OF DR. LUSH'S PAPER ON GENETIC-ENVIRONMENTAL INTERACTIONS

BY

W. C. Rollins

It has been an honor for me indeed to be on the same program with Dr. Lush whom I consider the Dean of Livestock Geneticists. His scholarly, pertinent and critical review of the literature and actual experiments now underway in the area of genetic-environmental interactions has given to me "a laborer in the vineyard" increased perspective. This, of course, from Dr. Lush is what we all over the years have come to expect.

Prior to opening the meeting to general discussion on Dr. Lush's paper I would kike to use a few minutes to do the following: (a) philosophize a bit on Dr. Lush's remark about linear models and (b) to tentatively suggest a type of beef cattle research that might be done within the conceptual framework of the topic under consideration.

(a) During the last 40 years geneticist have become model conscious. This has aided them in conceptually dealing with reality. However, the price paid has been to restrict the scope of the problems tackled and sometimes to almost throw the real problem away along with the trimmings resulting from various limiting and unfortunately in some cases unrealistic assumptions. The venerable linear hypothesis is now being viewed with a more jaundiced eye but like the old Model T Ford, if I may mix metaphors, it got biologists on the quantitative road. We have now traveled the road enough to demand more sophisticated models. One of a never ending series of corners is being turned.

(b) Consider the sex of a bovine (bull, steer, heifer) as inducing different physiological environments in which to test arrays of genotypes resulting from various mating and selection schemes. For example, paternal 1/2 sib groups of males might be randomly divided into steers and bulls for, say, testing rate of gain. With the increased demand for cheaply grown lean beef the marketing of young bull beef may become more prevalent. Would it not be worthwhile to know the genetic correlation between rate of gain of bovine as bulls and as steers--to state the genotype-environmental interactions problem in Falkner's terms?

Information of this type, that is, sexual environment-genotype interaction (to coin a phrase) in some instances might be accumulated with relatively slight modification of existing designs; in some cases it may just reduce to looking at the same situation through different spectacles.

The meeting is now open for discussion from the floor.

Working Together for a More Effective Beef Cattle Breeding Program

-by-

E. J. Warwick[1]

Webster defines cooperation as "Collective action, as in industry, for mutual profit or common benefit."

The W-1 project was organized in 1946, NC-1 in 1947, and S-10 in 1948. Thus, workers in these three projects have had long experience at cooperative efforts in the research field. Anything I may say tonight should not be interpreted as any failure on my part to recognize past achievements. Rather, I feel we should both recognize the good points of our program and face up squarely to the areas where greater cooperation is likely to be necessary in the future.

Cooperative efforts have in general been of four kinds. First has been that kind of cooperation in which personnel of an institution or an individual field station have mentally examined the broad field of problems in beef cattle breeding; discussed them with their coordinator, with other members of the technical committee, and with others; and have developed projects within the limits of facilities available which in their opinion would be of maximum usefulness in solving problems of regional or national importance as well as of personal interest to them. Free exchange of experimental results as individual projects progress has further influenced the development of new and revised projects in a region. At the same time, however, a very high degree of individual sovereignty has been maintained. There are those among our critics who feel that this type of cooperation has not really been very effective - that beef cattle research in the United States would have developed in much the same fashion if there had been no Federal-State cooperation and no regional projects. This is, of course, a point which must remain in the realm of opinion but I for one can't agree. Rather, when I see new and revised projects come in, set up to study specific problems which have been discussed earlier at technical committee meetings and which I know have been of deep concern to coordinators and others, I am driven to the conclusion that this type of voluntary and perhaps partially unguided cooperation has been of even greater than expected usefulness.

A second type of cooperation has been in the pooling and publication of data from several locations in single regional-type publications. A few such publications have come out in past years and several more are now in process of preparation. I, personally, feel very strongly that we should follow this route of publication with all suitable material, recognizing full well that not all material is suitable. There are several reasons for this. First, none of us today find time to read everything we should and putting material together where possible rather than scattering it in many individual publications increases our ability to keep up with publications in our field and thus makes the research results more useful.

[1] Prepared for presentation at the combined conference of W-1, NC-1, and S-10 Technical Committees, Stillwater, Okla., July 25, 1960.

Second, the pooling approach reduces the total number of publications and should serve to somewhat reduce the load on our constantly growing and over-burdened technical journals and bibliographic and abstracting services. Third, from a purely practical standpoint it will increase the prestige of regional projects if there are a reasonable number of regional publications which can be clearly recognized by administrators as output of that project. There are those who shy away from cooperative publications perhaps partly because they feel their own personal advancement and reputation depend upon a long list of publications. I, personally, doubt that this is the case in many places.

A third type of cooperation has involved transfer of breeding stock from one station to another where animals we e available that were of potential usefulness at the second station. A good deal of this has been done and almost without exception stations have given other stations first priority in acquiring animals often at a considerable financial sacrifice. Such cooperation has been most helpful and has strengthened the bonds of projects.

The fourth type of cooperation is that in which projects are jointly planned by two or more stations and the work is carried out at two or more locations under a jointly developed overall plan. Although to date most such efforts have been of an informal or semi-informal nature, we have had several examples of research planned and carried out in this manner. Perhaps the best example was the effort on evaluation of the X-ray technique as a means of detecting carriers of dwarfism. In this work representatives of Iowa, Nebraska, Oklahoma, Tennessee, and the U. S. D. A. met on at least two occasions, reviewed the data previously accumulated, evaluated needs for additional information and laid plans for getting the needed information. This was informal but, at least in my opinion, quite effective.

The Colorado, California and Mississippi stations have exchanged bulls and obtained progeny information in more than one location. Bulls from Tifton, Georgia; Miles City, Montana; Front Royal, Virginia; and McGregor, Texas, have also been progeny tested at the Mississ ippi station. Bulls from South Dakota and Oklahoma have been progeny tested at Fort Robinson, Nebraska. Miles City bulls are being progeny tested in Arizona.

Thus, "type four cooperation" has been practiced on occasion but it has been to date a minor part of beef cattle breeding research activities.

Certain types of research virtually demand this type of cooperation if they are to be successfully carried on.

The first of these is the study of genetic-environmental interactions. Will the kind of Hereford cattle most productive in Montana also be best in Florida; if good in Virginia, will they also be adapted to California? Indeed, is the Hereford breed or any one breed best for all these locations or for the multitude of land quality and management situations even within relatively limited geographic locations? We may, and most of us do, have ideas

on these questions. On purely logical grounds it appears reasonable that cattle should be bred in areas and under management situations similar to those in which they will be raised commercially. If there are special adaptation factors, selection for them will be automatic. Many of us have pointed this out to cattlemen but to date there's little evidence that it has been taken seriously in the industry. A few prominent herds in each breed, usually located in areas favorable to beef cattle production, represent mecca to a great percentage of the less prominent or "second layer" breeders the country over so far as herd bull source is concerned.

If genetic-environmental interactions are unimportant this procedure is truly superior. Conversely, if specific adaptation is important, the industry is doing itself untold harm. As research people we should be in a position to provide the answers - today we can't do it. Thus, whether our own logic or intuition tells us such interactions are important or unimportant, we need to have data for the industry.

Trials to get such information could be set up in numerous ways. Some on such things as plane of nutrition and type of management can often be handled within station and I am happy that several places, including Iowa, North Carolina, South Carolina, and perhaps others are attacking the problem. We also have a small project at Beltsville using monozygotic twins.

Wider scale trials, however, will entail cooperation of two or more stations if they are to be successful. Further, it would appear that maternal traits, including fertility and mothering ability, should receive emphasis.

It is beyond my purpose here tonight to outline such studies but examples of how they might be accomplished may be in order.

The most efficient approach from the standpoint of numbers for preliminary trials on the existence of interactions is the use of monozygotic twins although with them there are certain inherent difficulties. The simplest kind of a trial would be to assemble several pairs of identical twin heifer calves, put one member of each pair in each of two environments, raise them to maturity, breed them to the same bull by artificial insemination, or to identical twin bulls, and get records on whether there are significant differences in rank at the two locations in growth, fertility, weights of calves raised, or in other traits indicative of general thrift or adaptability to the environment. Thirty to forty pairs of twins with part of them unsplit in each environment for control purposes, should give reasonably good estimates of whether or not specicific adaptations exist in beef cattle. Another type of experiment which will give information of the same kind would involve breeding two or more bulls to cow herds in different areas either concurrently through artificial insemination or naturally in different time periods. Much larger numbers would be needed than with twins.

A more crucial type of experiment, however, would entail something about as follows: Set up two comparable cow herds at two locations either by

exchange of stocks or a division of a herd from one location. At each location assign a given number of cows (more than half) to a group to be maintained as a closed population and selected for a single trait or for an index based on objective measures so that exactly the same selection program would be followed at the two locations. The smaller portion of the herd at each location would be bred by artificial insemination to the bulls being used in the selected herd at the other location. Thus, side by side at each location would be a herd selected for performance at that location and one selected for performance at the other. The comparative performance of the two strains at each location and the correlated responses, if any, should give an excellent idea of the real importance of specific adaptations. Fifteen to twenty years would likely be required for definitive results. I can ask, without attempting to answer, how many replications would be necessary.

There are probably other equal or superior designs, but it is certain that adequate experiments on this problem will require quite a hit in the way of facilities and will require real cooperation-possibly sacrifice on somebody's part - of research in which he has a special interest in order to carry on broader studies in the interests of the overall program.

Another problem where "type four cooperation" will be necessary if progress is to be made, is that of providing controls to ascertain progress or lack of it in selection programs. So far as I know, this problem received little emphasis during the formation of the regional projects. At that time it had received little emphasis in any large animal breeding study and to my knowledge very little even in poultry breeding. The passage of time and developments in other species, showing that heritability estimates are not necessarily indicative of progress which can be attained from selection, have emphasized the importance of the problem.

It is certain that providing adequate controls, regardless of the method or methods adopted, will require a greater degree of cooperation and a different kind of cooperation than has been necessary in the beef cattle breeding projects to date. As well as cooperation in the actual research itself, a united front will be necessary if the funds needed for adequate work are to be obtained. As long as we work at many locations with limitations on cow numbers at each place, the maintenance of separate, random-bred herds of sufficient size to provide reliable bench lines is a physical impossibility.

As most of you are aware, several of us have for some time felt that the long time storage of germ plasm offered an effective approach to the problem of measuring progress as well as having potential usefulness in other areas of research. With present techniques for storing cattle semen, we have every reason to anticipate storage for five years and some people are dreaming of much longer periods.

We have furthermore felt that a program of long time semen storage of greatest potential good to the nation's beef cattle breeding research program, as well as other breeding projects, could best be accomplished by a single

centralized laboratory having the storage of semen and research on problems of germ plasm storage as its prime responsibilities.

There are, of course, other possible mechanisms for getting the semen storage job done. One is for each station to take care of storing its own semen. In some cases this is perfectly feasible, but, unless done in conjunction with an artificial insemination stud, the outlays for equipment and overhead in toto would in all probability be greater than for a single central laboratory. Further, the quality of techniques used in collection, processing and storage is likely to be lower if this work were not the primary responsibility of the people doing it. Probability of accidental loss of stored material would be greater for the same reasons.

It has also been suggested that the job could be taken care of by artificial insemination studs - either private or cooperative groups. This again might be feasible in certain cases, but by and large the business of a stud is to merchandise semen and even if they are freezing semen, it moves into commercial channels relatively fast. Thus, to serve a long time storage function additional equipment would be needed and, in effect, a new business developed parallel to an existing one. Further, we wonder whether the stability of most such groups is dependable enough to tie to for a program which may well extend 20 years or more. We have looked into this possibility and have found one or two groups willing to discuss the matter but none exhibited a great deal of enthusiasm. Again, we feel that, everything considered, a publicly owned facility is preferable. A proper set-up of this kind would include storage at two or more locations as a hedge against catastrophe at a single place.

The establishment and maintenance of adequate random-bred control populations at each location does not appear to be feasible but as Dr. Stonaker in particular has pointed out, this does not mean that such a herd could not be maintained cooperatively with a small group of cows being kept at each of several locations. An undertaking of this kind would be most effective if the same bulls, or a sample of the same bulls, were used at each location each year. Thus, as I'd look at the problem, a semen storage and distribution facility would not be competitive with a cooperative random-bred herd but rather they would complement each other. The semen storage facility would ease operational problems of a random-bred population maintained at several locations. Further, long time storage with repeat use of sires at intervals would provide information on genetic drift or lack of it in such populations. Random-bred populations are useful in many ways in addition to use as bench marks for evaluating progress in selection programs.

How many stations should cooperate in maintenance of a single random-bred herd, how many cows should be at each location, how many different random-bred beef herds there should be in the nation are questions you can answer better than I. This meeting provides the best forum we're likely to have for some time for the discussion of these problems and I hope we take advantage of the opportunity.

In conclusion let me reiterate that the cooperative beef cattle breeding research effort represented by this gathering has been an outstanding example of cooperation and has been widely recognized as such. It thus stands as a monument to the foresight of those who developed the program nearly a decade and a half ago. It is also my opinion that we will have to engage in more "collective action -- for mutual profit or common benefit" if we are to effectively meet some of the obvious needs of the work.

EFFECT OF WINTER FEED LEVEL ON GROWTH AND REPRODUCTIVE PERFORMANCE OF THE BEEF FEMALE

The effect of plane of nutrition on growth, fertility and longevity has been the subject of much research with cattle (1), sheep (2), poultry (3), swine (4) and laboratory animals (5). Since Osborne and Mendel's and McCay's classical research showing that rats which were restricted severely for long periods could exhibit remarkable recovery when given a liberal diet, and survived for longer periods than those fed liberally, the need for greater knowledge concerning the effects of restricted feeding of farm animals has been apparent. Current knowledge on the subject has been best reviewed by Hammond (6).

Particularly is this important with beef cattle. Unlike most species, beef cattle undergo different management practices and have certain unique characteristics which set them apart from a nutritional standpoint. For example, the beef female requires a longer time to reach sexual maturity than most breeds of dairy heifers, and breeding is usually delayed until at least 15 months of age, and often 27 months. Moreover, she has a longer gestation period than females of other species, produces only one offspring and, has been shown by extensive Arkansas studies, isa relatively poor milk producer (7). The fetus produced is smaller in proportion to her body size than with other species, and re-breeding usually occurs during the best pasture period of the year. She also suckles her calf for a relatively short period.

Then, too, beef cattle are somewhat unique in that for centuries, selection has been made for ability to fatten readily. Thus, the beef female often builds up large excesses of body fat under liberal feed and pasture regimes. She is, therefore, more susceptible to high planes of nutrition which may prove detrimental to reproductive processes or lactation. Many beef cattle are fattened excessively in preparation for shows and sales.

On the other hand, under certain range conditions beef females may have little winter feed available and make poor growth as heifers, or lose excessive amounts of weight before or after calving. The detrimental results of such low feed levels have been obvious to the industry for years, and are consistently warned against nutritionists. Yet the accumulative effects of different planes of nutrition over the life span of the beef cow are unknown.

Many authorities have failed to allow for the recovery capacity of beef cattle, as has been amply illustrated by the extensive research of Winchester and associates at Beltsville with identical twins (8). Also, it has been demonstrated that excessive body fatness in the beef female is of little value in terms of milk production (9), and that her ability to respond to increased lactation by the use of thyroactive materials, for example, is very poor (10).

Prepared by L.S. Pope, Oklahoma Agr. Exp. Sta., for the Joint Meeting of the NC-1, S-10 and W-1 Technical Committees, Ft. Reno, July 26, 1960. Data shown are taken from Okla. Mis. Pub. MP-57, pp. 60 and 81, and J. E. Zimmerman, PhD Thesis, 1960, Oklahoma State University.

Extensive Cornell studies (11) have failed to show that dairy heifers are adversely affected by low planes of nutrition during growth and up to first parturition, and Tennessee studies (12) with Jersey identical twins showned that liberal feeding during growth depressed milk production in first and second lactations.

From the animal breeder's standpoint, the effect of plane of nutrition is vitally important if it influences or masks the expression of maternal traits, affects reproduction, and shortens the useful life span of the beef cow.

EXPERIMENTAL

To further study this problem, a long-time project was initiated at this station in 1948 and has been supplemented with companion studies at Lake Blackwell with fall-calving cows, and at Stillwater with identical twins. Seven trials involving 450 beef females have been completed, or are in progress, at the Ft. Reno station. In the first trial, 120 weaner heifer calves were started on test in October of 1948 to study the lifetime perfomance of beef females receiving different amounts of supplemental winter feed on weathered range grass, as follows:

Low - 1.0 lb. cottonseed meal per head daily
Medium - 2.5 lb. cottonseed meal per head daily
High - 2.5 lb. cottonseed meal plus 3.0 lbs. oats

One-half of the heifers on each level were bred to calve first as two-year olds, the remainder as three's. The females grazed native grass pastures (predominately bluestems) year-long and received supplemental feed from early November to mid-April each year. At present, the cows are approximately 12.5 years of age and have their 10th and 11th calves at side. Cows have been removed from test only for failure to calve or raise a calf for two successive years, or for disease or unsoundness that would preclude the usefulness of the female to the project.

Starting in the fall of 1954, a series of repetitions of this project were initiated with heifer calves, largely out of the original cows described above. Weaner heifer calves were allotted to treatment on the basis of sire, productivity of dam, age and shrunk weight to provide from 3 to 4 groups each year. In order to provide wider differences in winter gain or loss, and thus enhance the effect of different levels of wintering, most heifers have been fed to make a predetermined rate of gain for the first winter as weaner calves, and for subsequent winters as bred heifers, as follows:

Treatment	1st Winter's Gain As Weaner Calves	Subsequent Winters As Bred Females
Low	None	Lose 20% or more of fall weight
Moderate	0.5 lb./day	Lose 10% or more
High	1.0 lb./day	Lose no weight
Very High[1]	Maximum rate	Gain at maximum rate

[1] Two repetitions only

In order to establish these rates of winter gain or loss, the supplemental feed allowance on weathered range grass was varied according to body weight changes during the winter. Actually, it was necessary in most years to place low level females in drylot on wheat straw, with no supplement, for 2-6 weeks to initiate weight loss, follow by range and no supplement until late January, and only limited amounts thereafter. In contrast, heifers fed for maximum gain ahd access to a 65% concentrate mix in self-feeders each winter. The moderate and high groups were wintered on native grass, plus 2 to 10 lbs. of supplemental cottonseed meal and milo per head daily, as necessary. A mineral mix of 2 parts salt and 1 bone meal was available to all heifers throughtout the year.

All heifers were bred to calve first as two-year-olds to further increase the effects of various treatments. Bulls were placed in the pastures May 1 and removed August 15, thus the bulk of the calves were dropped in late February and early March.

OBSERVATIONS

1. Levels of wintering which result in no gain as a weaner heifer calf and a losss of approximately 20% or more of fall weight during the first and second gestations and post-calving periods, will adversely affect per-cent calf crop and weaning weight of the calves, retard maturity and delay conception in the young females.

2. To a degree, reduced winter gaines or body weight losses are recovered on good summer pasture. While maturity is delayed in poorly fed heifers, skeletal size is little affected and such effects as do occur are largely recovered at 3.5 years of age. For optimum skeletal development, the medium level treatment appears ample.

3. Levels of feeding above the medium treatment have not been profitable. Very high planes of winter nutrution do not appear to affect conception, but increases calving difficulty and reduces number of live calves at weaning.

4. Mature size of beef cows is only slightly affected by poor winter feed levels, if recovery is possible on good summer grass.

5. Calving dates, as they probably reflect appearance of first heat after calving, is directly related to winter feed levels.

6. Birth weights are adversely affected by poor winter feeding in young females, but to a lesser extent with advancing age.

7. Accumulative percent calf crop to 12 years of age in one study has been greatest for cows receiving the least amount of supplemental feed (1.0 lb. cottonseed meal per head daily). This tendency has become more noticeable since maturity.

8. Useful productive life in the herd appears to be shortened by liberal winter feeding. Removal of medium and high level cows has been principally due to more unsoundness, disease and failure to calve or raise a calf for two consecutive years.

9. These studies point up the need for additional research with beef females, and the importance of feed level on reproduction and productivity. It would appear that in the nutrition of the beef female, we must operate between two danger areas, the extent of which is unknown.

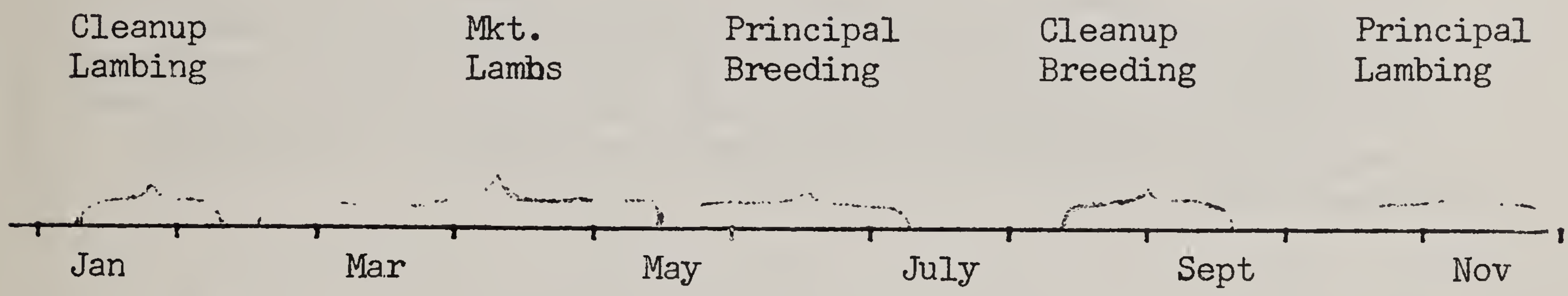
THE FORT RENO SHEEP BREEDING AND MANAGEMENT PROJECT*

Title: Methods of producing milk fat "spring" lambs.

Project leader: J. V. Whiteman

Herdsman: Richard Pittman

Reasons for undertaking the work: The principal system of sheep production in Oklahoma and many other southern and southwestern areas is "so called" spring lamb production. This involves a May-June breeding season which is abnormal for most breeds of sheep. The Fort Reno ewe flock is managed on the basis of the following calendar:



This project generally was undertaken to permit observations on problems inherent in such a system of production in addition to the following specific objectives:

Objectives:

1. Study factors influencing reproductive perfomance of ewes.
   a. Management
   b. Genetic
2. Study management factors influencing ram performance related to the breeding season.
3. Develop more effective selection procedures for use in sheep improvement.
4. Check the advisability of raising replacement ewes as opposed to buying them.

Results in brief:

1. Shear flock 5-10 days prior to the beginning of the breeding season rather than 5-6 weeks earlier.
2. Of the purchasable ewes available in the Southwest, Rambouillets appear more productive than various crosses between Rambouillet and Merino, Columbia and Panama.
3. 1/2 Dorset replacement ewes appear to be more productive than any of the above. A higher percentage of the ewes lamb and they produce and raise more twins.
4. Rams appear less fertile during May and June than during the fall and apparently require more special provision for their comfort than is usual during the fall. Cooling by artificial means or good shade areas appear equally desirable.

* Operated in cooperation with ARS, USDA

5. Lambs on wheat pasture and creep feed may be weaned at about 45 lbs. or 70 days of age, whichever comes later, without materially influencing their subsequent gain or market grade.
6. The heritability of lamb gains has been found to be about .10 from birth to weaning but increased to about .45 form 50 to 90 pounds suggesting that effective selection for gaining ability can be made on lambs prior to market time.
7. Under these conditions one-half Dorset replacements from the flock have produced more lambs by three years of age than purchased replacements have by the age of three and one-half years. (1/2 Dorsets are bred first as lambs; purchased yearlings are bred first as yearlings.)

The flock is presently composed of about 540 ewes of which 179 are six years old (the remainder of our original 200 ewes purchased as yearlings in May 1955); 175 are one-half Dorset lambs, yearlings, two or three year olds that have been raised; and the remainder are two, three and four year old samples of white-faced southwestern range ewes.

PROPOSED REVISION OF FORT RENO BREEDING PROJECT

Doyle Chambers

LINES	6	7	8	9	10	11
BREED	ANGUS	ANGUS	ANGUS	HEREFORD	HEREFORD	HEREFORD
MATING SYSTEM	CLOSED	CLOSED	OPEN	CLOSED	CLOSED	CLOSED
TYPE OF SELECTION (Sires)	PHENOTYPE	PROGENY TEST	PROGENY TEST	PHENOTYPE	PHENOTYPE	PHENOTYPE
TRAITS SELECTED (Sires)	TOTAL MERIT (12-Mos.)	TOTAL MERIT (12-Mos.)	TOTAL MERIT (12 mos.)	TOTAL MERIT (12 Mos)	TOTAL MERIT (7 Mos.)	ZERO Sel. Dif.
NUMBER COWS	40	40	40	40	40	40
NO. BULLS PER YEAR	2	2	2	2	2	4
"REPEAT" SIRES	1	1	1	1	1	0
PROGENY TEST	NONE	4 BULLS 100 COWS	4 BULLS 100 COWS	NONE	NONE	NONE
		(per year)	(per year)			